

July 25, 1960

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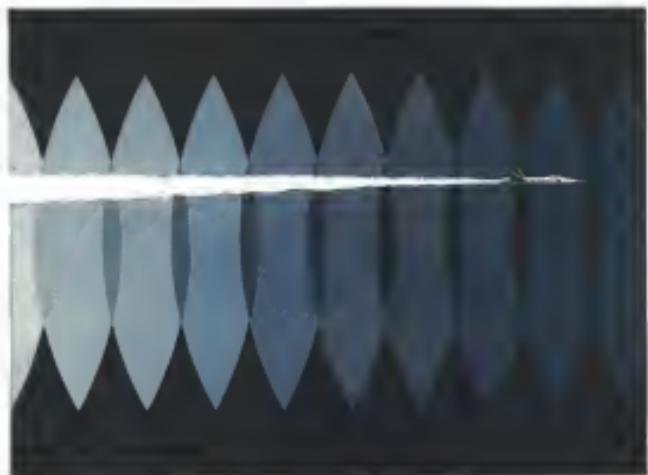
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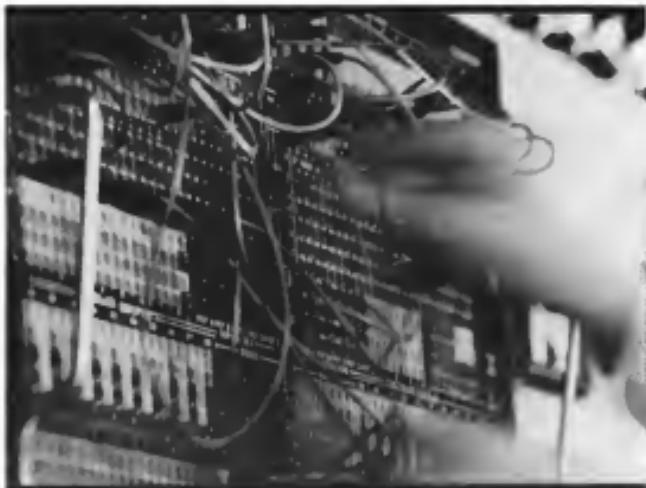
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A 150	117,000 140,000	146,000 170,000	187,000 210,000	0.25 0.35	15.80 16.00
Air Metal	112,000	150,000	190,000	0.35%	14.00%
Desmattei	145,000 160,000	172,000 187,000	212,000 230,000	18.00 14.00	20.00 18.00
DA-4C	104,000	160,000	200,000	4.5%	20.0%
DA-4C	134,000 140,000	194,000 204,000	234,000 251,000	9.5%	18.0%
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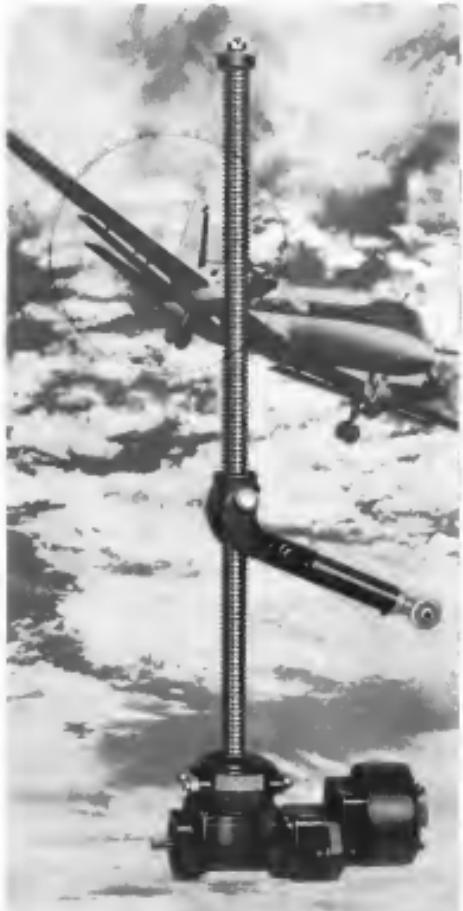
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Robert E. Haynes problems through research in part of Haynesville a complete metallurgical service. This micrograph is used to observe metals at 2000 deg. F.

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Washington Roundup

Kennedy Defense Plans

Domestic presidential nominees See John F. Kennedy may push for more defense money during the August session of Congress, even though the final 1961 defense bill already has been completed. If Kennedy were elected, this would provide the fresh fire to expand the defense effort quickly in Japan.

Kennedy will work with top advisers that week in defense defense and other issues he may want to develop during the August session. The Democratic nominee favors increasing the defense budget \$3.5 billion a year, and some of that increase could be voted next month.

National Aeronautics and Space Administration will keep industry this week on future needs in all its major areas. Budgets are expected to total 1,200 to 1,300 representatives to the July 23-25 sessions, which NASA headquarters is running as an invitation-only basis.

Briefings will cover subjects ranging from advanced research to the practical question on how to do business with NASA. Advanced research discussions will cover general problems plus aerodynamics, flight mechanics, space propulsion systems, power generation and structure and materials. Launch vehicle sessions will cover current designs, Saturn advanced vehicles and nuclear units. Space research, satellite programs, human and planetary probes and manned space flight also will be discussed.

Higher than anticipated spending for military and space programs in the last six months failed to keep the federal budget from registering a surplus for Fiscal 1962. Defense Department spent \$235 million and NASA spent \$76 million more during the year than was estimated in January. But reductions in other areas paved \$1 billion from total spending estimates and produced a \$3,368,000 surplus.

Seamans Joins NASA

Dr. Robert C. Seamans, Jr., will take over a management office that grew significantly in its first year of operation when he becomes associate administrator of NASA on Sept. 1. The office has grown from two men on June 1, 1959, to the present force of 16 professionals and seven secretaries.

Richard B. Howard has held this number three job on the space agency, essentially a general manager's post, since it was created a year ago. He is leaving to join Northrop Corp.

Seamans is chief engineer of Radio Corporation of America's Missile Electronics and Controls Division and has been with RCA since 1935. He held technical and project manager positions for 14 years at Massachusetts Institute of Technology, heading its Flight Control Laboratories from 1953 to 1955. Seamans served on National Advisory Committee for Aeronautics Technical committees from 1948 to 1958 and is a member of USAF's Scientific Advisory Board.

Special House Appropriations Subcommittee established to study the Air Force Nuclear Propulsion program has been dissolved. This group comprised of members of regular subcommittees on public works and defense was formed to advise the public works subcommittee on \$3.5 million from the atomic energy budget for the ANP project. Appropriations committee later instead of the funds, taking the money out of the ANP budget.

Now the issue is whether a Defense Department ANP study due Oct. 1 will be handled by the Defense or the public works group. Rep. Melvin Price chairman of the Joint Armed Forces Research and Development Subcommittee, has discounted reports that the Defense study will recommend cancellation of either the General Electric fast reactor program or the Pratt & Whitney nuclear engine approach.

Manned Aircraft Hopes

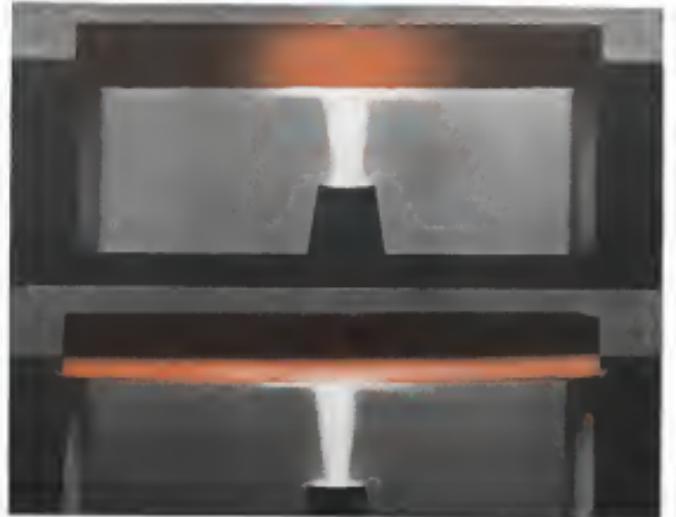
Defense Department and industry hope to get some firm answers on the future of manned aircraft and the future course of the military's advanced aircraft and space technology hopes to get a fix on how much aircraft work will be available and what type it will be. Pentagon wants some realistic estimates of what will be advanced aircraft work.

Future usage of unmanned vehicles from Defense's VTOVLs to Dyna-Sat will be answered at a joint Department of Defense/Industry of the Aerospace Sciences conference. It will be held in San Diego Aug. 13. One prime topic will be Mach 6.10 hypersonic aircraft with a range of a fourth of the earth's circumference. Most consider this a research but, between the X-15 and Dyna-Sat.

Congress will tackle the long question when John Robert, deputy director of defense research and engineering, discusses the economic disease for manned aircraft. Robert will be the economic problem to requirements for fighting different types of air.

Services are expected to present a detailed series of future aircraft requirements as they now see them. NASA will discuss technical areas available now and expected to be available to meet military requirements. Industry will estimate what can be accomplished with current aircraft in the coming year.

—Washington Staff



HEAT SHIELD panels made of pyrolytic graphite (bottom) are lighter and more effective than commercial graphite (top).

Pyrolytic Graphite Studied for Re-Entry

Radiation heat shielding technique may save weight and improve re-entry velocities and accuracies.

By Michael Yaffer

Extensive development work now under way on new graphite materials and structures may soon lead to radically new ballistic missile re-entry vehicles and reentry capsules which work principally through radiation rather than ablation or heat storage.

New radiation heat shielding techniques could lead to significant savings in weight and improvements in re-entry velocities and accuracies. One nuclear contractor that sees graphite reentry structures will weigh only one tenth as much as current ablation reentry vehicles (AVW July 15, p. 34). It will come in tangent elliptical form, and will also be winged. In reentry modes and blunt bodies, new materials report cells will also permit sensible savings in weight as well as the use of high energy projectiles with high combustion temperatures and high initial velocities.

Currently, most interest is centered on pyrolytic graphite (AVW July 15, p. 39), a highly oriented crystalline material. First major applications of the material are expected to be in the rocket nozzle and reentry capsule of an improved 1,500 lb Polaris reentry vehicle using ballistic reentry.

Navy Special Projects Office, prime and military sponsor of research and development on pyrolytic graphite, now in the process of establishing major reentry evaluation programs for pyrolytic graphite material and structures with Lockheed reentry vehicles and

Aerospatiale. First flight test of a pyrolytic graphite nozzle will probably take place on a Polaris AX-2 test vehicle later and more sophisticated versions of current AX-2 test vehicles in about 10 months. That flight test of the PC reentry structure will be uncrewed.

Now contractors are generally highly enthusiastic about pyrolytic graphite and pyrolytic graphite-based materials. Results of research sponsored by the Special Projects Office over the past two years, a Navy affair, have led to the full-scale development of the material for ballistic missile applications.

As Avco is interested in graphite generally for high temperature applications but is more interested about pyrolytic graphite in particular. Last month, Avco Research and Development Command awarded National Carbon Co. a division of Union Carbide, a three-year \$12 million contract for research and development of graphite for missile

and space vehicle components. Both Avco and National Carbon feel it is time early in development to focus on graphite such as pyrolytic or perhaps in another such as graphite cloth.

At the same time, if it is not necessary, also that pyrolytic graphite will load or will go into Avco's Monolithic SCM. All three Monolithic series contractors—Trulok, Aerjet, and Hydromet—have in late contracts out for work on pyrolytic graphite nozzles. It is also conceivable, but less likely, that pyrolytic graphite will find its way into other reentry structures of existing vehicles. Other possible applications for pyrolytic graphite are: high strength, reusable heat shields for manned reentry vehicles such as the Project Mercury capsule and the Gemini space capsule.

These principal Navy contractors working on research and development of pyrolytic graphite are: General Electric, High Temperature Materials Inc., and Kevtron. In addition to the Navy's Special Projects Office, three companies are doing pyrolytic graphite work: Aerjet, Andover, and Convair Corp., Douglas Electronics, Jet Propulsion Laboratory, Lockheed, Radiation and Thermal.

Despite enough pyrolytic graphite, the Navy contractors are working in a field of pyrolytic graphite and not only pyrolytic graphite fibers and coatings. At least one contractor, High Temperature Materials, is experimenting with the application of pyrolytic graphite processing techniques to another high temperature material, boron nitride. Boron nitride has a critical time scale similar to that of graphite and it may prove to be more oxidation resistant.

Orbited Graphite

Pyrolytic graphite is essentially a highly oriented graphite. Compared with commercial graphite which can reach an orientation ratio of 3.0 to 1.0 to 1, three crystals with three c axes oriented perpendicular to the surface for every one basal oriented parallel to the surface, pyrolytic graphite has an orientation ratio from 100 to 1 to 1,000 to 1.

For the missile case, the attraction of pyrolytic graphite stems from its pyrolytic form, its high thermal conductivity that is, its ability to conduct heat rapidly, in one direction and blade, in another. Thermal conductivity of pyrolytic graphite will run 30 to 1,000 times higher in a direction parallel to the surface, says a High Temperature Materials scientist, than in a direction perpendicular to the surface. At the same time, the material retains the high reflectance (reflectance of light) of graphite, approximately 0.689.

Excellent conductors of heat, the graphite

making it impossible to transmit through the PC accurate vehicle temperature signals that would be required for data acquisition or storage. To get around this problem, HTM has developed a device which it can use to achieve close to 100% transmission of losses and requires no electrical connection and is designed for the reentry vehicle. When the heat load from reentry is released, the device is caused to start to melt around 1,200°. At this temperature, radiation heat transfer is not too significant. But radiation rises by a factor of 2 with temperature. Thus at 8,000°, the surface heat transfer is roughly 16 times greater and more important. However, says an HTM scientist, a Mark IV type of reentry vehicle of pyrolytic graphite would reach an equilibrium temperature of 1,000°. If reached, the radiation heat transfer of the graphite. In this temperature difference, he has the potential for shortening the reentry velocity by further streamlining of the vehicle body.

Heat Diffused

Local heat input per unit area is much higher at the tip of the nose cone than at the rear nose cone. High-velocity heat from nose cone of solid materials would dissipate quickly. In the nose of pyrolytic graphite, heat is more diffused, so the temperature would have to spread out over the surface, bringing the center towards surface to reduce the heat loss. At the same time, a Materials Institute scientist, the characteristic series to block the heat going through the PC heat shield.

It is possible, streamlining of pyrolytic



PYROLYTIC GRAPHITE products are now used to fabricate a variety of shapes such as these produced by High Temperature Materials Inc. What appears to be first in some of the streamlines are simply cutout pieces.

graphite producers, to obtain a low pressure drop of approximately 4,000 psi across a panel of 201 cells 135 cells thick. In the case of ceramic vehicles, this means that the metal backup structures can be made from the light-weight but relatively low temperature metals such as aluminum and magnesium, reducing weight. In the case of rocket vehicles, it means that the heavy metal liner need not carry with it the weight of the insulation.

Today's graphite, if it is correct, has graphite graphite insulator high resistance to erosion and oxidation in the presence of the propellant used to maximize thrust. The high surface temperature of EG materials also tends to discourage the formation of oxide deposits from propellants with high metal content. This same requirement is also met by the fact that the EG materials have high heat resistance, the constant threat of letting it escape into a heat sink. Also, since graphite graphite does not oxidize at room temperature, the necessary insulation is required longer. This factor is even more critical in early applications where changing configurations can lead to undesirable instability and loss of thrust.

Propellant graphite is such a hot area, but the ability to produce the material in large quantities is now. Basic research has been done to produce the original concept of running hydrogen gas such as methane or natural gas through a system of heat exchangers at temperatures ranging from 1,800 to 2,900°. At the gas temperature, the carbon deposits on the tubes, leaving them with a carbon coat as the byproduct. Hydrogen is used more extensively than natural gas.

The oxidized graphite needs of some companies, may become part of the rocket structure. If it is not to be used in the flooded part, it is broken away from the pyrolytic graphite propellant which is then insulated and either used as it is or attached to a different substructure.

Joining or bonding pyrolytic graphite to other graphite is one of a number of problems of EG propellants as they relate to solid rocket motors. When a pyrolytic graphite structure cracks, it tends to break away in one direction, inducing stress in the material. Production peaks as High-Tensile Materials are trying to work out designs and other possible variables so that they can eliminate pyrolytic graphite structures in such a way that these stresses won't affect the other propellants at the material.

Today we want to let long term applications, establish operating methods and set a defense research and development policy.

The military services agreed that separate systems requirements dictate distinct research by each. An accomplishment would be beneficial. This approach sets the framework for each agency to continue basic and development research under broad guidelines from York.

These were other major points discussed.

• System of using Air Force and Navy design services for Army research con-

cerns and/or subcontractors. EG propellers are still working on the problem of dissolving propellants such as gain and density. Once the material's properties are completely clarified, the problem becomes one of developing non-destructive inspection techniques to measure these properties. Another important consideration, however, is to integrate control of process variables to ensure that a given set of properties can be obtained upon demand.

Handling also is a concern of a problem with graphite graphite structures, which are extremely brittle at room temperature when compared with metal structures. High Temperature Materials does not consider this a problem and uses that as one in handling all that is required. In fact, large EG propellants don't contain any of these problems insurmountable, and figure that they could go into production of half scale units with confidence in a matter of months.

The heating factor, then, is the time it will take to maximize for ground and flight evaluations.

Defense Policy Council Airs R&D Management

Washington—Defense research funds will satisfy specific management problems in a broad effort to consolidate the \$4 billion research, development, test and evaluation program. This is one result of the first management problem conference sponsored by the Defense Research and Engineering Policy Council held recently in Ft. Monmouth, N.J. (AVW, July 11, 21).

At the conference, military service managers dealt with their civilian and military program managers and a variety of general management problems in the growing research and development effort. Discussions ranged from staff and facility-to-facility exchanges to frank office on what the military services were doing. Dr. Herbert F. Yalkin, director of defense research and engineering, and chairman of the conference, said:

"Today we want to let long term applications, establish operating methods and set a defense research and development policy."

The military services agreed that separate systems requirements dictate distinct research by each. An accomplishment would be beneficial. This approach sets the framework for each agency to continue basic and development research under broad guidelines from York.

Perhaps the most critical problem at this time is that of quality control to

prevent difficult communications problems with clients. Different requirements for the same article result in compromises which affect performance.

• Government research and development needs guidance from cut-off test, proper bonding, unanticipated

loss of continuity, a more aggressive

cast process, torch management devotions and a working atmosphere conducive to research.

• York's offer is increasing somewhat insulation as surface decreases by driving in more adequate initial insulation and by reconstituting clean houses with the joint Chair of Steel.

• Government laboratories should not compete with industry, each plays a different, mostly supportive role. Industry should be assigned EG propellants tasks, except in special circumstances, beyond the metal problems.

• Individual service management themes with the tendency to mix-control and overgrowth, but allow future identification of non-polymer research and development.

• Government laboratory problems include many facets of program planning, plans, efforts to cooperate, test, help of support for research and development, construction, selection of personnel, and changes during the contract cycle.

• Audit lead to revised, and there is frequent "close direction of research" from outside the laboratory.

• There are phases in the life cycle of a weapon system in development, debugging and service use. The second phase should be used to correct deficiencies as the completed system is evaluated and should not be a prolonged inspection process. This leads to "rework" by extended ranges which probably the project effort from meeting its requirements performance goals are an effective substitute for bold leaps.

• Transition of the mission of the Air-launched Missile Range from pure weapons test to include space launch support has added problems of testing, troubleshooting, and closure of the research and development cycle.

Today we want to let long term applications, establish operating methods and set a defense research and development policy.

• System of using Air Force and Navy design services for Army research con-

Boeing Cancels Report at ARS Meeting

Columbus, Ohio—Report on a propellant system claimed to significantly extend the specific impulse performance of liquid hydrogen and liquid oxygen was canceled by Boeing Aerospace Co. at the last moment at the American Rocket Society's Propellant Combustion and Liquid Rocketry Conference.

With a representative gas generator system with regard to bonding and required operating functions, Haasenrath reported, indicating that a redesign of approximately 80% in potential problems can be solved through use of the tag-on system, a significant reliability advantage for future engine designs.

At the same time, he pointed out, the performance of the tag-on system is comparable to that of a conventional engine.

In the current type of bipropellant gas generator system fuel and oxidant are fed from the same propellant tank, fed first and burned in a separate combustion chamber to produce the hot gas required to power the turbine that drives the propellant pump. Such systems require precise propellant sequencing, ignition, injection and flow control.

Top-Off Operation. In the top-off system, the engine is started with a small propellant turbine.

Combustion products are fed from the first chamber, through a hot gas duct to the turbine and then out through an exhaust duct. By the time the turbine burns out, Haasenrath said the turbine had already made a second transition in the bleed gas.

A comparison of the two systems made by Haasenrath revealed the following:

• Conventional bipropellant gas generator units have to perform seven different functions, while the top-off system performs only two.

• Gas generator requires 13 components, the top-off four.

• Gas generator has 11 start units, the top-off system has three.

• Ignition at Rockwell's is not required, but appears to do, mainly a combination of the feasibility of a liquid oxygen RP-1 top-off engine system.

Before this engine can be fully developed as a flight engine, Haasenrath said, a lot more work will be required to determine if the top-off techniques which have evolved from this program can be applied to ultimate propellant combustion, bonding, investigation and operating levels. If this proves to be the case, he said, he is having them show the tag-on's potential, then, he said, to see if the technique will be readily available for obtaining significant improvements in the reliability of large bipropellant rocket engines.

GAO Report Highlights Space Competition

By Evert Clark

Washington—High degree of competition that has made space hardware development more expensive and complicated again last week, a GAO committee's hearing investigation of the choice of Douglas Aircraft Corp. to build the fourth stage vehicle for the Saturn space vehicle.

That was the fourth major National Aeronautics and Space Administration development program to issue such a costly congressional review since NASA was created less than two years ago. Others are the F-1 engine, the Mercury capsule and the 700,000-lb thrust hydrogen engine contracts.

Aside from the Mercury program, which the Senate says was the most important national competition held to be in the space program, these four, along with a declining number of military aircraft and missile systems, answered NASA's call for bids. Then followed 16 large aircraft programs and the Chrysler Corp., which had built the Jupiter intermediate stage.

Stage Combinations

The Saturn stages, designated S-IV, has an importance beyond the fact that it is the first large rocket engine developmental program to be awarded by NASA. It is to have five and possibly six different stages, to be used in a number of combinations. The first stage is to be developed and assembled by NASA's Marshall Space Flight Center, at Huntsville, Ala., at least through the first 11 or 12 vehicles. Subsequent stages are considered from the house up, and the fifth stage or S-V, already in long development by Chrysler, is to be built from the Atlas-Centaur vehicle.

The three intermediate stages and a possible sixth stage, therefore, are the only ones to be developed by private industry, and are to be purchased by AVAISON Windham Corp. with the rest of the program. Chrysler's work on Centaur is to be limited to a key service in the system's exploration of space, and building for all phases of its development will be hard fought and may play a large role in deciding which companies will remain in the space development picture in the future.

Chrysler hoped it had an advantage in the competition held last spring by being at hand with the former Army team at Marshall on the Redwine and Jupiter missiles and on Saturn's first stage. Chrysler, then developing the only liquid hydrogen stage in the country (Centaur or S-V), thought that gave it an advantage because stages two, three, four and the proposed nuclear

stage will all be hydrogen-fueled. All the companies involved hoped that the winner of the S-IV stage would have an advantage on the advantage that when NASA opens bidding on stages two and three which will be the large 200,000-lb thrust hydrogen engine.

An NASA technical evaluation committee, a business evaluation committee and a source selection board reviewed the bidding last April. Contractors were narrowed to three—Chrysler, Douglas and North American—and then North American was eliminated.

On April 19, the source selection board made a recommendation to NASA Administrator T. Russell Clinton. Clinton subsequently reported that the selected "the most advanced stage based on the evaluation process, the technical performance, the proposed cost in great detail, and the board's analysis of risk factors." Therefore, I selected the Douglas Aircraft Co., Inc.

Source inferred that he had precluded the selection of Douglas and the two plants that followed from this, prompted the House Committee on Science and Astronautics—among other congressional groups—to investigate.

Clinton visited the following four rooms in house "among the candidates" influencing his choice.

Devalued experience. This is for Douglas and Centaur "since the same, as in most other areas, is not the best, but a 'dug out,' which did not seem to be as bad as it could be."

The Douglas proposal, in sum, was deemed more responsive. Government, the safety review going to Centaur, the safety review going to Centaur for the business committee would mean to reinforce only that attention to certain of the details of organization was lacking. In the course of negotiations of the contract, either of these shortcomings could be remedied in all probability. Centaur's work on Centaur is to be limited to a slight edge in the technical competition.

Competition. Considerable competition must be given to a consideration of the desirability of at least limited competition as we start off this new technology," Clinton said. "Should all work be awarded to one company, it might well be the case that subsequent competition for the other stages of Saturn would become quite severe. A noncompetitive position in this field seems possible and should be avoided unless substantially unusual costs would be involved or unreasonably complicated management arrangements result."

"An examination of these factors provides a negative result—that is, no fa-

vorable cost or management problems are expected to arise if a second industrial organization enters the field," Clinton continued. "Indeed, some benefits may well accrue. Redistributing the industrial base for hydrogen vehicles with selection as to the first stage will assist NASA's program to follow this path (early in funding development) of the 200,000-lb thrust hydrogen engine in Redwine, which was developing the 11,000-lb thrust hydrogen engine for the fourth and fifth Saturn stages."

With regard to Clinton's statement on costs, Chrysler bid \$78,305,000 and Douglas \$84,418,000, exclusive of tax, for the \$49 million difference of \$5,44 million.

Participation. Both Douglas and Centaur are present. As Centaur continues, but NASA would like to reduce the S-IV work, there will be interaction with any program planned. As for the program, German and USAF offered assistance. "That support was available in both organizations—perhaps a bit more completely at Douglas, but quite possibly available in Centaur."

Share of Business. "Centaur's responsibility with Centaur (S-V) covers a large share of production because for that purpose the S-V will be used both with Saturn and Atlas; in fact, may well become one of the 'work horses' of the space program in both military and civilian applications," Clinton said. Then, less of the S-IV contract has manufacturing features in the initiation of development than disturbing features in the possible low of significant amounts of ongoing basic work. Both contractors will continue to be healthy—not necessarily starved to achieve acceptance."

Interest in Chrysler

Although Clinton's comments dealt with the relative positions of Douglas and Centaur, the space committee just now of the House of Representatives in Chrysler's position, since Chrysler had proposed building a plant near the Saturn launching site at Cape Canaveral, Fla.

Clinton's comments dealt with the relative positions of Douglas and Centaur, but the space committee addressed two of three "areas of interest" to Chrysler's situation in asking the Government Accounting Office to study the Saturn award.

Chrysler had proposed building a plant on a 1,000-acre site in North Merritt Island, Fla., one from the Saturn launching pads if it were the award. This was not, as the committee told GAO it had heard, a "plan" for development of the fourth stage, and was not



Westland Westminster Fuselage Enclosed

Westland Westminster helicopter manufacturers, long flown with an advanced structure expand (AW May 18, 1970, p. 96), is shown with the fuselage broken over to show a longitudinal section. Internal structure is new. Note at a four blade tail rotor with a variable pitch head was ready July 17 (AW July 18, p. 38).

to be built with (Chrysler's) own funds" in the telecommunications business. It may be an incentive, and some test buyers may be attracted to the technology.

Any ultimate Chrysler proposal to build the new facility on the Tennessee River near the Marshall Center in Huntsville where stages must go to the cleared and cut out areas on Saturn's first stage before they go to the launch site—was rejected by the business committee which had found the Florida site was "well selected and optimum for the program," according to GAO.

The other two aspects which GAO was asked to investigate were:

• "Possibility that the government will have to buy the plant" when it was sold from its plant in California to the Cape Canaveral launching site. GAO found that transportation plans in all proposals were acceptable to the business evaluation committee despite the standpoint of time required to deliver the ship, from California to Alabama.

GAO found that the source selection board said that avoidance of the proposed plant would be the down side factor in choosing top place for industry to build the fourth stage. The industry, plus Chrysler's proposal, was the first to propose a larger hydrogen/hydrogen peroxide plant, located at West Palm Beach, Fla., only 200 yards from Chrysler's proposed assembly and test site.

Chrysler, according to the GAO, had estimated that \$2,745,000 would be saved for government/furnished equipment. Of this, \$2,617,000 would have been applicable to the assembly and test facility. To reduce funding required to complete the plant, Chrysler proposed to transfer its

do not appear to be a significant part of total development cost, GAO said. Contractor estimates for transportation and total development cost, excluding tax, were: Centaur, \$784,800 out of \$300,300,000; Douglas, \$424,800 out of \$300,400,000; North American, \$174,000 out of \$42,299,000; and Grumman, \$141,000 out of \$41,819,000.

• An addition to Clinton's statement that broadening the industrial base in hydrogen technology "placed an important perhaps increasing part" and that "another contractor might have been selected if it had not been for this consideration."

GAO replied that "74 areas" preferable to research from Clinton's statement, and the consideration of broadening the industrial base in hydrogen technology was the deciding factor. Whether the consideration was a compelling factor in its own right, or whether it was enough sufficient to tip the balance between Douglas and Centaur cannot be determined."

The license committee under Chairman Overton Brooks (D-La.) has paid much closer attention to NASA's award of the London B-700 F-1 engine contract to Rockwell, the McDonnell Douglas team, and the team of Rockwell to develop the 200,000-lb thrust hydrogen engine. No report has been issued on the London B-700. The committee also initiated GAO's recent investigation of the acquisition of NASA's Vega space probe program.

The Strategic Aerostatic and Space Sciences Committee who has kept a critical eye on NASA's procurement from NASA's employee list that this critical situation is not of wonder and that some situation might better be turned to procurement priorities of other more experienced agencies.

Russians Assembling Large Hydrofoil Boat

Moscow—Khrushchev's factory has started assembling the Soviet Union's largest hydrofoil boat, the 700-passenger Spatnik, which will have a top speed approaching 42 mph., according to Moscow-controlled Press.

Russia's hydrofoil boats were to have first a report of reported expanding of a rapid rate on Soviet waters. A Soviet 1,400-ton hydrofoil assembled on Lake Baikal, a 1,300-passenger Soviet hydrofoil, made its first Moscow-Cosko run, in July and later will be merged to Cosko Koskovo's operation on the Volga River (AW July 14, p. 170).

More than 70 hydrofoil "Radar," each capable of carrying 60 passengers, are expected to be in regular service on the Volga and such large Siberian rivers as the Lena, Angara, Yenisei and Irtysh by the end of the year.

trip between Egypt and Israel, from Cairo to Leopoldville. C-124s began ferrying troops from Gabon to the Congo. Two additional MATS squadrons were assigned from U.S. to help in the assault.

A USAF spokesman and his last week, he expected the U.S. assault by the U.N. to continue for a "long time," leaving an additional troops, supplies and equipment, before the last vestiges of the Congo can be completely crushed to local authorities.

The large bodies of troops being ferried in the Congo by USAF are down in increments since they are accompanied by 200 tons or more of equipment. Troops, for example, have been flown in by aircraft, 937 in the first, 490 in the second. Another 1,000 are still to follow. Macmillan has delayed a similar schedule—930 in

the first increment, 670 in the second, with 1,350 to follow.

Initial steps leading to the assault actually were begun July 9 when the Defense Department alerted the U.S. Army, counterpart to Leopoldville and C-130s were to move them in to be ready to move in the U.N. needed a Congo assault force in meeting order.

During the period before July 15 when the assault began in earnest, USAF C-130s transported two assault battalions to Leopoldville to assist in the evacuation of European residents from the country.

Helicopters that have been flown and maintained by U.S. Army troops, but will be the U.N. force gain strength, they will be turned over to other nations, probably Sweden or Norway. Errors, U.S. wants as few of its own troops as the area as possible.

During all stages of the emergency which was set off by naming of the now-independent republic in the former Belgian Congo, the assault at Leopoldville was short of all kinds for about 24 hr with the return to control. Subsequent principally from those during this time.

Soviet Participation

In another development last week,

Russia reportedly was joining the assault with three B-52 transports en route to Leopoldville and two were scheduled to follow. The Soviets announced that the first planes were provided to ferry Ghana troops to join the U.N. forces.

Two of the aircraft were carrying food

and medical supplies.

• **Afrikana** has made four flights between Brussels and Rome for the Italian government, using DC-8s and DC-10s. The Italian carrier probably will make additional national flights.

• **Ukrainian Airlines** former carriers from Soviet East Asian ports on Soviet Convair and DC-8 flights to points further north. The Convair will be used to move 1,000 tons of 100,000 which were taken off from Leopoldville's 15,000 ft runway at new cargo plane weight of 100,000 lb. On the 3,600 m runway flights to Brussels, passengers are crowded four and five abreast with children crowded along the aisle and seats tilted spaciously. Because of the large percentage of children and infants riding up the plane seats, and the weight of luggage—most adults carry only a handbag—the plane is able to leave Leopoldville with a cargo loads ranging from 250 to 280 passengers. One flight carried 299 passengers and 10 crewmen, the extra crew being required to care for the women and children.

Other airlines are pitching in through charter arrangements with Sabena or by

Brazzaflis and Brussels, bringing in food and taking out refugees. Leopoldville also has made several Super G flights for the Congo government, bringing in food and medical supplies and bringing out refugees.

• **Sabena** flies a DC-8 from Zurich to Leopoldville with powdered milk consigned to the Swiss government, and was scheduled to make two additional flights into the Congo with food and meat with refugees. The U.N. had to cancel the Swiss contribution.

Indirect help is coming. Sabena's regular routes, primarily of Sabena's own craft, is being provided by other airlines. For example, Alitalia has taken over Sabena's Rome-Braunschweig route. British European Airways provided those special flights for the London Braunschweig run.

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FAA Extends Installation Deadline For Turbine Transport Recorders

Washington—The Federal Aviation Agency has extended its regulation requiring the installation of flight recorders on all turbine-powered aircraft to give airlines an extra two to eight months to buy and install the equipment (AVW May 16, p. 30).

All turbine-powered aircraft weighing more than 12,500 lb at takeoff, including the Lockheed Electra, Fairchild F-27 and the Vickers Viscount, now carry recorders which can record time, heading, altitude and vertical acceleration. They were to be installed by Nov. 1, a two-month extension by Lockheed Aircraft Service, said.

The two-year extension permits extension of this Nov. 1 deadline to May 1, 1961, in any case where the owner submits to FAA written evidence that it will be unable to comply with the aircraft manufacturer's date because of procurement or installation problems. FAA and extension also will be granted in cases where the owner can show that it has taken steps to ensure the progressive installation of recorders at the earliest practicable date after Nov. 1.

The extended regulation provides the extension to cover recorders that integrate aircraft and engine recorders to exceed 12,500 lb aircraft weight of more than 12,500 lb. It also covers takeoff weight which are notified for operating above 35,000 lb altitude.

Large turboprop transports and piston-engine aircraft operating above that altitude already are required to carry the equipment under Part 45 of the Civil Air Regulations.

The regulation further requires that flight recorders must be installed not later than the first of the month following the event or midflight hedge of the calendar. FAA and the aircraft may conform to the next step for maintenance repairs. Recorded information must be retained by the airline for a 60 day period or longer if required for a series of flights by either FAA or the Civil Aviation Board.

While FAA noted that it recognized the advantage of allowing the airline industry sufficient time to assimilate more complex recorders which would provide better accident data, the agency also referred to the agency's expected installation of more local service offices that F-27 operators should be exempt from the regulation on the grounds of heavy costs and low altitude operation.

Explaining its stand on the F-27, FAA pointed out that its notice of proposed rule-making stipulated that the

regulation was to include all of the new types of high speed, turbine-powered airplanes, "whether certificated to operate above or below 33,000 ft, since they are frequently subjected to weather atmospheric forces."

• **Turbojet Avon**, in its original comments on the proposed rule change, estimated it at the basis of available information supplied by the manufacturer on the use of extended flight recorders which can record time, heading, altitude and vertical acceleration. They were to be installed by Nov. 1, a two-month extension by Lockheed Aircraft Service, said.

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"base type" aircraft on the route if the aircraft were fitted (AVW May 30, p. 3).

Turbo Avon on the more expensive aircraft was generally 30% below that class fare. Allegheny offers the service for \$11 on the 204 to Philadelphia-Pittsburgh route, between Philadelphia and Boston the fare was special for \$11.66, and between Philadelphia and Providence it is \$11.82.

FAA, Airlines Agree On Noise Program

Washington—Voluntary industry acceptance of a standard system of noise abatement procedures for turboprop and turboprop aircraft was announced last week by the Federal Aviation Agency.

Adopted as a result of a joint FAA-airline study of the problem during the past five months, the plan will be integrated into present pilot training programs and operational manuals of all airlines.

Part of the program is to arrive at a set of simplified operating procedures which can be applied to individual aircraft to reduce aircraft noise during takeoff and landing even further.

Pointing out that there is a "practical limitation" to just how far it can expect to go successfully with the noise problem by passing new traffic rules, FAA emphasized that the success of the plan will rest with the airlines through strict compliance with the new standards.

The standard operating criteria, resulting from the joint study, will be issued by FAA in a separate document this week. The noise abatement plans will be issued by the airlines to the service in the Philadelphia-Pittsburgh market. Allegheny recently added the service to routes between Philadelphia-Charlotte, Boston and Providence, and will add the Newark-Elizabeth-Passaic as well as the Niagara Elangated-power Coast route.

Operating factors formulated by the study are the same in most categories for all three hub-and-spoke transports. They include: 2,000 ft altitude under which the noise abatement plans procedures apply on the theory that that altitude is where the aircraft can be most effectively maneuvered. Minimum altitude and degree of bank to turn for the flights is set at 300 ft and 20 deg. maximum descent angle is 2.5 deg. and maximum descent maneuvering speed limit is set at 200 ft. up to an altitude of 3,000 ft.

Similar standards were established for the turboprops, with a 3,000 ft altitude limit for climb, 2,000 ft minimum altitude and 20 deg. of turn to bank as a means of reducing maneuvering speed, and a minimum altitude of 3,000 ft set to commence descent to final approach.

Airlines, USAF Aid Evacuation Of European Refugees From Congo

Major airfields of European countries out of the new Republic of the Congo and of troops and supplies into the country area continued last week as additional soldiers and USAF units had to move thousands of soldiers and tons of food and material into Leopoldville.

Belgian World Airlines' entire jet fleet of five Boeing 707-300s continued chartering between the Congo and Brussels, carrying as many as 180 passengers each. Eighty flights were suspended transatlantic routes. Job 9 to put on air route for European refugees, and also was using eight DC-8s, 11 DC-6s and a DC-4 in the airfield.

Charter Assistance

By midweek, about 17,000 persons had been ferried out of the Congo by Sabena, with many additional from chartered flights of other carriers. The Belgian airline was putting an average daily effort of 14 hr on its aircraft, 10 of which were taken off from Leopoldville's 15,000 ft runway at new cargo plane weight of 100,000 lb. On the 3,600 m runway flights to Brussels, passengers are crowded four and five abreast with children crowded along the aisle and seats tilted spaciously. Because of the large percentage of children and infants riding up the plane seats, and the weight of luggage—most adults carry only a handbag—the plane is able to leave Leopoldville with a cargo loads ranging from 250 to 280 passengers. One flight carried 299 passengers and 10 crewmen, the extra crew being required to care for the women and children.

Other airlines are pitching in through charter arrangements with Sabena or by



SWISSAIR's first of three Douglas DC-8s made 12 round trips between New York and Switzerland during first month of operation.

Swissair, SAS Cooperate on Jet Support

By Cecil Brevannes

Zürich-Swissair and Stockholm-Svenskair Airlines Systems are jointly working a tightly knit maintenance and training structure designed to permit the two carriers to support the operation of three different jet transport types that can never be in the same stage lengths of their respective route structures.

Part of the plan is an interesting "soft, soft" agreement covering two of the three types involved, completed with a close liaison program both within and beyond the framework of a maintenance contract that provides for progressive spare and engine pools for the Douglas DC-8 (SWISS Air 4-p, 451). It also covers the two remaining aircraft, the Convair 580 and a small, two-engine Air Charter-cargo.

• **Swissair** is moving four Model 1 Skys-Caravelles from SAS for flights over relatively short stage lengths of 400-600 miles. All four aircraft are scheduled to be operating over Swissair routes within Europe and in the Middle East by early August. Although legally part of SAS, they will be under Swiss management. SAS has an option to repurchase the aircraft four years after their delivery to Swissair if it chooses. Major maintenance, spare pooling and spare parts of most of the spare parts needed for the four aircraft will be the responsibility of SAS.

• **SAS**, beginning in April, 1961, is scheduled to move two of its several versions of the afterburned Convair 600 medium-stage transport

in order to Swissair, complementing those with two others it has purchased directly. Spare parts, progressive major maintenance and crew training for these SAS and Svenskair Convair 600 aircraft—named the Convalescens by Swissair (SWISS Air 5, p. 151) and which may be designated the 900 by Convalescens—will be handled by the two carriers in a manner similar.

The two Convalescens obtained from Swissair will be legally owned by SAS but, as in the case of the Convalescens, can be repurchased by the original owner after they have been in operation for four years.

• **Svenskair** and SAS will operate as a team within the Swissair agreement to pool spare parts and engines for the intermediate DC-8. Under provisions of the contract, each of the two carriers will be entitled to one-half of the intermediate spares and engines and to one-half of the intermediate spares and engines at designated intermediate bases while all the aircraft can draw on a small carrier's inventory by a longer airline could be available.

DC-8 cooperation with SAS also extends beyond the spare pool, with Svenskair Airlines System assuming responsibility for all but low altitude voice on the three aircraft Swissair will have in service by September. Flight training is conducted at Arlanda Airport, a 45-minute drive from Stockholm, primarily because of its remoteness from inhabited areas, wherein the situation surrounding Zürich-Kloten Airport is somewhat nonexistent. The two Swissair flight training programs, however, are under the direction of Swissair instructors.

From initial service, Swissair is trans-



FIRST Convalescens obtained from SAS began service with Swissair May 21. Two Convalescens now fly to London and the Middle East.

ing a total of 44 pilots for the DC-8, with the first group of eight now completing its training.

The pilots, who are from training flight crews, are DC-8s and DC-6s, and are first sent through a five week pre-flight course at Zürich, involving 24 hr. in Swissair's Curtiss-Wright-built DC-3 transports, before reporting to Arlanda for training aboard one of the two aircraft which Swissair now has on hand.

Original flight training syllabus is laid down by the airline called for 12 hr. of flight training. In practice the flight has been trimmed to an average of only 6 hr. Swissair says that has been sufficient for the senior pilots drawn on for the DC-8.

Spaced between four and 10 days in Arlanda, a pilot is taken through the complete flight regime including low altitude maneuvering, two-engine-out flights and approximately 21 landings (including 11 IFR approaches). The training plane is flown up to 12 hr. a day during which it makes approximately 18 landings.

After Arlanda, the pilot has an option to Zürich for additional orientation training and another 12 hr. as the conclusion. He then receives directly the cockpit in either a Convalescens or regular flying the regular passenger run between Zürich and/or Geneva and New York, making the first three flights with a senior cockpit steward.

As a package to the program, six Swissair instructor pilots were sent to Douglas' Long Beach, Calif., plant where they received a total of 14 hr. flying time before going to Arlanda to complete their training under two Douglas flight instructors.

Details of the Swissair/SAS jet co-

operation agreement were worked out after the Swissair planes had begun appearing for the DC-8, and each carrier had justified a contribution on its own from Curtiss-Wright at a cost of approximately \$3.84 million each. Swissair, however, is sharing the SAS-purchased Convalescens originally located at Bromma Airport near Stockholm and, in turn, is buying a Convalescens similar from Radion, Ltd., of London, for use by both carriers.

Making maximum use of its DC-8 resources, Swissair has scheduled the aircraft for 5 x 7 flights and then adds the equivalent of six and 31 p. m. (switching through its own pilots and flight engineers and, under lease, turbines from two French airlines, Transports Aériens Internationaux (TAI) and Union Aéronautique de Transport).

During its first full month of opera-



PAW of Swissair's 31 Convalescens 400s line the ramp at Zürich-Kloten Airport, the airline's home base. The Convalescens make 58 flights a day on Swissair's short-haul European routes.



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from Mar. 30 to 3, or 50-1/2 DC-8 flights round trip between New York and Zurich. Searus, with four jets for overload at Zurich, will be flying to Mac, with Convair flying out the Searus order with delivery in June and July.

Configured for 92 economy, 26 first class seats, the aircraft had an enclosed passenger load factor of 92.9% as opposed to 58.9% roundtrip and the 53% which Ameri-Baumwolle, Swiss air executive vice president for planning and research, estimates at the DC-8's present speed on the North Atlantic route. It also carried 10,351 lbs. of freight and 11,695 lbs. of fuel, for an overall load factor of 61.9%.

The Convair, with 50 economy and 26 first class seats, carried 7,435 passengers between Zurich and London on 20 roundtrip flights during its first month of operations between Mar. 21 and June 21. With its 9,718 lbs. of freight and 11,396 lbs. of fuel, the Convair established an overall load factor of 61.9% for the month.

During the most popular flight of the day, a 11 a.m. 15,500-kilometer run from London, the aircraft established a passenger load factor for the month of 51.4%.

Each day a second Convair was placed in service, with the two aircraft alternating between flights to London and the Middle East on the following schedule:

- Convair leaves Zurich at 9 a.m. for London, arriving at 10:35 a.m.
- Convair departs London at 11:30 a.m., arriving Zurich at 1:15 p.m.
- A second Convair leaves Zurich at either 2:30 p.m. for Athens or at 2:57 p.m. for Ankara.

• 5-round Convair takes off from London at 4:40 p.m., arriving at 6:15.

• Athens leaves London at 7:45 p.m., arriving at Zurich at 8:35.

• Second Convair leaves Zurich for London at 9:50 p.m., arriving at 11:25 p.m.

• Ankara leaves London at 1:30 a.m., arriving at Zurich at 3 a.m. and goes into nonstop nonstop routing to pasture for the 9 a.m. flight to London and, in the afternoon, marching over to the Middle Eastern run. The first plane, minus white, returns to Zurich and goes into nonstop nonstop routing before taking over the 4:40 p.m. flight to London.

All four Convairs are scheduled to be on round trip routes with flights to London, the Middle East, Madrid and Scandinavia.

In its flying program, a Searus Convair pilot incurs approximately 162 hr. of technical instruction on the ground, 14 hr. in the SAS flight simulator and an average of 44 hr. as the air, including approximately 32 IFR approaches and 22 landings.

Under present scheduling, Searus will move its first Convair Convair 880, apparently three

aircraft below an unpermitted route line, by the Federal Aviation Agency. Both Searus and SAS will make one aircraft in April and another in May, with Convair flying out the Searus order with delivery in June and July.

Both Searus and SAS will use the aircraft for the training of flight crews and maintenance personnel pending FAF certification, putting them into service in early July to the Far and Middle East, South America and the SAS route, South Africa.

Each Convair will accommodate for both airlines with seven seats on the supervision of Searus, although an alternate flight will be made available at Zurich, bringing the aircraft to Zurich. To help maintain the aircraft, Searus is establishing a string of 12 spares depots across the Middle and Far East, each stocked with between 10 and 15 General Electric CJ-665-10 engine spares. A similar program for the Middle East is under way by SAS, which will have the Searus aircraft at but not near, Tif Aviv, where a parallel service is not offered by the Scandinavian airline.

To ease the maintenance problem and parallel these efforts, for its first flight, Searus also is considering the possibility of eventually converting its Convairs to the Mirk VII configuration, substituting two 16,000-lb-thrust CJ-665-234 for the present installation of two 11,700-lb-thrust Rolls-Royce Avon engines.

Once the Convairs are in service with 12 flight crews and 50 economy seats, Searus will pull back its Convairs from the Middle East to replace its present European workload, the Convair 880, an outgrowth of the longer route, Baltimore-Wiehle, which 400 mi. in about the shortest ring length over which the Convair can be profitably operated. Searus may be forced to return to Europe for charter runs, however, in order to maintain flight schedules from other carriers. As Tif Aviv, for instance, already is offering Convair route service on the slightly less than 300 mi. run between Zurich and Paris.

In another move to meet competition, notable Boeing 707 service by Air India and Air France, and gain an airway included in the jet market at the time, Searus may place one of its aircraft on its route to the Far East with TWA, the other to the Far East at the end of October when the carrier's new schedule for tourist flights resumes to Asia and the carrier's jet flights across the North Atlantic are truncated from 12 round trips a week to seven.

The route is presently served by a Boeing DC-8, which identifies itself on its way to Tokyo from Zurich at approximately 64 hr., as opposed to the

26 hr. flight with stops planned for the Convair.

Despite the weight of jet passenger traffic and the fact that during most of the year it had to use piston equipment in competition with jet transports on its major routes, Searus in 1958 realized a net profit of approximately \$1.75 million as compared with \$1.05 million in 1956, and paid a dividend of 65¢ to its 10,562 stockholders.

Annual utilization for the two aircraft is 18 hr. per day for each of them in 5 DC-8s, 9.1 hr. for each of the 12 Convair 880s and 7.8 hr. for each of six 11 Convair 440s (Searus hopes to reach a utilization rate of 10 hr. per day for its jet transports).

The Convair 440 utilization rate looks particularly good in view of the short stage lengths it generally flies. It has a typical one day schedule for a single 440:

- Geneva to Zurich
- Zurich to Munich
- Munich to Frankfurt
- Frankfurt to Paris
- Paris to Geneva
- Geneva to Zurich
- Zurich to Geneva

To maintain such a schedule, Searus has adopted the blocktype progressive maintenance system and runs its maintenance headquarters in Zurich as a threefold round the clock. Block scheduling as much maintenance and overload work as possible for the late night and early morning hours when there is no competition with regular flights. To the great extent, work is overload periodically programmed for the months of winter and early spring when flight schedules are at their lowest.

Fuel Shortage Cuts

Delta's Cuba Payloads

Athens-Delta Air Lines DC-7Bs in 77 passenger configuration are flying nonstop from New Orleans to Havana, Cuba, via Miami, with a nonstop return flight to New Orleans. The return flight is a start of aviation practice in Cuba.

Shell Oil Co., Delta's since supplier in Havana, has advised the airline that it cannot be responsible for what little fuel is available. As a result, Delta flights departing New Orleans are carrying fuel for the round trip and paying the penalty as payload.

The mid-September Delta flights to Havana are limited to three flights weekly at a time of audience flight factors (SWP) Mar. 25, p. 47). During December, January and February of 1958-59, the peak Cuban tourist season, Delta carries 1,245 passengers between New Orleans and Havana. Last year, the comparable figure was 704 including only one package vacation trip linked to Cuban government tourist promotion.

ALL WE CAN OFFER THE AIR CARGO INDUSTRY IS A PRACTICAL WAY TO MAKE MONEY!



CANADAIR CAN PROVE TO YOU THAT:

YOUR piston powered passenger carrying aircraft now rendered obsolete by new equipment, and being considered for use in cargo operations, or already actually converted can be completely removed from fleet inventory and written down to zero book value in three years.

ONE THIRD the number of Canadian Forty Fours will carry out your cargo requirements at such a profit that they will absorb all expenses incurred in the retirement, deactivation, plus any earnings your piston engine aircraft would have realized during these three years.

AFTER THESE THREE YEARS, the Forty Four operating profit curve will climb steeply. The difference in profit potential for the following years is substantial.

Any consideration of a specific example requires certain

assumptions regarding scheduling, future rates, and load factors, but, under a representative set of conditions our analysis indicates—that a fleet of 25 piston powered aircraft currently being converted into cargo carriers, could be replaced and rotated by a fleet of 8 Forty Fours. The above assumptions and statements are based on the unlikely premise that cargo rates will remain at present levels. If they are reduced, as seems inevitable, the situation will favor the Forty Four even more strongly.

THE FORTY FOUR. The Canadian Forty Four, with its combination of low direct operating costs, high block speeds and large payload capacity is the world's most economical cargo aircraft. Flying schedules can be arranged to introduce the Forty Four into airline service fourteen months from contract agreement.

CANADAIR LIMITED, MONTREAL, CANADIAN DIVISION OF **GENERAL DYNAMICS**



Soviets Change An-24 Serial Number

Original paint job on the Russian state airways An-24 (serial CCCP-81950, or 15, p. 39) may have proved embarrassing to Soviet officials. Serial number on the craft was 81950 (15/98 L15595), indicating that the craft's factory tailcode may have been planned for last year. Within two weeks after the L15595 An-24 appeared, the craft was displayed again with a more new paint job—the first with the serial 81950 (15/96). Carelessly, Aeroflot announced that the An-24 had begun test flights

Pressure Rising in Soviet Union For Better Airline Ground Service

MOSCOW—Pressure is rising in the Soviet Union for more vigorous efforts to shorten the time required for the transfer of goods from the gate of flight to ground storage or loading passenger operations.

Construction of ground facilities is lagging and the article of airport personnel is insufficient to meet needs, according to the Soviet press. Russian editors are demanding that terminal access conditions be improved to the point where they match the quality of Aeroflot's but are surpassing.

The same response, Kirokoff said, is evidence of ground service shortcomings, since that the USSR's Soviet Civil Aviation provides for construction of terminals for 80 airports in 1969-1983 period.

But it took some sharp words with the supervisor to bring the program along so that "the ground can be brought up to the level of the sky."

In the air, Kirokoff observed, the passenger has a long "Tardis" syndrome: ankles feed him much and treat him to major snafus. He can carry a more flexible suit and more luggage on simple robes.

However, all this changes when a passenger gets off at a terminal point, or when he must be unexpectedly delayed at an intermediate station. One good or bad encounter transforms into a painful, fauna-oriented who забыл, wrote.

There are no across-coupling facilities to speed the right. There's only a place to wash up or to sit at while he waits for his connecting flight or for the weather to improve so that his plane can continue.

"At the visual, but, the cold and untrained passenger finds only little pictures of a very popular and very durable building—windshield—forevermore," says

both can tell the traveler how long he must wait."

On the ground, Kirokoff said, the ground gives the air traveler an vagabond experience, because it is inappropriate to greet him.

Aeroflot's Central Administration still holds in hands in a helpless, grueling. It pointed out that a new terminal plan can be built in a matter of days, but for 10 to 15 years are required as construction of a modest hotel or even a cafeteria. And by that time the sky has again moved forward, the hotel is once more too small and the drivers won't hold the luggage."

Quoted as Kirokoff on the lag in airport construction, the chief of Aeroflot's Capital Construction in Moscow said:

"Building personnel obviously believe that construction deadlines are established just to be violated. We should, for example, have completed the airport at Moscow's Vnukovo last year, but it's still not ready."

"The situation is no better in Moscow. The Main Moscow House Building Ministry is expert at disrupting project schedules. Construction at Kirokoff's has ranged on for 10 years."

One of the Russian air traveler's most vexing problems, according to Kirokoff, is trying to get served when on first class. "No one can seem to catch a meal with a meal," Kirokoff says. "They lose the baggag and it is held responsible."

During the interview with Kirokoff, Aeroflot Deputy Chief Bakshayev admitted that ground service shortcomings are a major headache.

"But what can we do? We still have ride and inefficient personnel. We are trying to train them but obviously our effort in this regard is having poor results."

"The T-14P Ok, it still hasn't left Moscow, the god of all the information center told Vlada with open eyes. Since the flight from Moscow required over six hours, Vlada returned home to Rostov."

"As a result the happy Aeroflot had to wait for another flight to Tbilisi, which he arrived 40 minutes later. It seems that her plane was not in Moscow but at Kirokoff (leads 180 km west).

"The Tbilisi information bureau

didn't know this and didn't care to know about it, although it should have been responsible for determining the location of delayed planes," Prokofiev commented Kirokoff. "Tbilisi Airport personnel were busy with more important things—such as discussing advanced methods of passenger service."

The Soviet magazine complained that Tbilisi airport personnel "don't stand above a lack of knowing and information. They have the walls at Erevan, Baku, Shiraz and other cities, bags and bags."

Kirokoff, Kirokoff observed, is attempting for sooner passenger changing places for Magadan that they wouldn't stand their luggage; that it will be moved to the right plane for them.

But on arriving in Magadan they are told that not even a name has been listed about their belongings. The Magadan airport, he said, is not even equipped with a baggage van. "Kirokoff, again?" They lose the baggag and it is held responsible."

During the interview with Kirokoff, Aeroflot Deputy Chief Bakshayev admitted that ground service shortcomings are a major headache.



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... now flying on United Air Lines routes and soon to enter service with American Airlines, brings jet-crated speed and comfort to more cities. Later the T-52 will go into service with Braniff, Irish, Lufthansa and Westair Airlines.

The superb 720 operates easily from shorter runways, yet cruises at more than 900 miles an hour. It's sleek, roomy and wonderfully comfortable...with the exceptional passenger appeal demonstrated by Boeing's new service.

BOEING 720

Airline Income & Expenses—May, 1960

2012-06-20

estimated transportation costs. ¹ Property taxes. ² Operating profit or loss.
Feb. 28, 1988, to May 31, 1988. ³ Freight & Harbor Freight.
Data by Aviation Watch from airline reports to the Civil Aviation Board.



FROM THE EXPERIMENTAL BUMPER IN 1950 TO THE ATLAS IN 1960...

CAPE CANAVERAL'S FIRST 10 YEARS OF MISSILE AND SPACE PROGRESS

Just ten years ago yesterday, the first experimental vehicle was fired from Cape Canaveral. Now, General Electric informs us this key U.S. missile and space research center's first ten years of progress...

A few men, a quickly constructed wooden "command post" and the firing of a hybrid Army Wac Corporal/V-2 missile called BUMPER 8 . . . this was the beginning ten years ago yesterday of what today is the largest missile test center in the world, Cape Canaveral.

AS BUMPER 8, developed under General Electric systems management, climbed away from the then Long Range Proving Ground Division, the only horizontal-launching landmark was a light house tower near a cluster of houses. Today, this scene has been dramatically changed, with miles of hard top roads leading to hundreds of launch sites, test centers, hangars, fuel supply areas and block houses.

Behind this changed scene lies a record of more than 800 successful launches that have been conducted by the three U.S. military services and other government agencies working with Air Force Missile Test Center personnel who maintain and operate "The Cape," or Station One of the Atlantic Missile Range and the islands "downrange."

These launches have paid immeasurable dividends. In the area of U.S. missile progress, Cape Canaveral test launches have led to the present operational status of Thor, Atlas, Jupiter, Starlok and Minuteman, and are now speeding the development of Polaris and Titan.

In the area of space technology, missile test flights from the Cape have proved the reliability of U.S. ICBM re-entry vehicles and the accuracy of U.S. ICBM radio command guidance, provided information on the belt of radiation around the Earth and other valuable data about space environment and flight that will serve scientists in their efforts to conquer space.

In satellite progress, the successful launches of Pioneer, Explorer, Transit, Telstar and other satellites from the Cape have paved the way for a whole new generation of orbiting bodies that will aid in conquest

of the universe, navigation, weather forecasting and in the protection of the Free World.

This progress has truly been the result of team effort. The military services and government space agencies together with companies like General Electric . . . a member of the Cape team since its Bumper 8 days . . . have joined together to represent communications, General Electric, Defense Electronics Division and the Defense Systems, Heavy Military Electronics, Light Military Electronics, Missile and Space Vehicles, and Ordnance Departments that are a part of this Division are proud to be members of this team and contributors to the program.

A unique 15 x 19-inch four-color illustration, suitable for framing, of the Atlantic Missiles launching from Cape Canaveral is available upon request from General Electric Company, Section 160-88, Schenectady, N. Y.

DEFENSE ELECTRONICS DIVISION

GENERAL  **GE** **ELECTRIC**

FIRST CAPE LAUNCH



X-17 THREE STAGE MISSILE



EXPLORER 1 SATELLITE



FIRST PAYLOAD RECOVERY



FIRST ABLATION ICBM CONE



FIRST POLARIS SHIP LAUNCH



LONGEST MISSILE FLIGHT



AMERICA IS ACHIEVING
IMPORTANT MILITARY
AND SCIENTIFIC PROGRESS
FROM CAPE CANAVERAL
INSTITUTIONS
LIKE THESE: ▶

Wac Corporal/V-2 missile called BUMPER 8 was fired by handful of Army and GE personnel on July 24, 1950. It provided vital data on basic for early missile progress.

First Thor in July, 1958, Air Force X-17 re-entry test vehicle was designed to achieve high re-entry velocity and yielded important information relative to ballistic flight problems.

This nation's first satellite was launched on January 31, 1958 from the Cape and is still in orbit. Army Jupiter-C booster placed this historic satellite into orbit around the earth.

First payload, a recovery satellite data capsule, to be recovered from space was launched by USAF Thor missile on May 19, 1958. GE built both re-entry vehicle and capsule.

First ablation missile vehicle to fly full ICBM range was developed by GE and launched on July 8, 1958 . . . passed feasibility of ablation for ICBM re-entry.

First Polaris shipboard launch was made from Navy's 5000 Observatory Island on August 27, 1958. GE is providing Polaris fire control and navigation systems.

USAF Atlas with GE radio command guidance and re-entry vehicle launched this May flew more than 9000 miles . . . longest Free World missile flight recorded to date.

AIRLINE OBSERVER

► Capital Shareholder Assn., employer-stockholder group seeking to oversee future management of Capital Airlines, has endorsed six of the 14 candidates for the company's board of directors. The group includes James Bond, Chairman, Thomas N. Nichols, Jr. and George T. Billard, who also is head of the Deltahold Holdings Protective Committee. The association also gave its support to members James R. Stockton, G. Bedell Morris and Raymond G. Luchak. It took no position on the selection of Charles Marchiono and George Hong, as it found that their share holdings were sufficient to ensure their selection.

► Midwest Airlines wants to take over the route between Kansas, N. Y., and Washington which Capital Airlines wants to drop (AW July 18, p. 45). Midwest has told the Civil Aeronautics Board it wants the route and would add Ultra-Rome and Hobbs to it. The carrier suggested that Alltaghway Airlines move Capital's present route from Washington to Buffalo via Wilkes-Barre and Hershey, Pa.

► Air France is offering 30-day-plus-later flights. Under an agreement with Credit Lyonnais, French state-owned bank, the flight plan covers not only the cost of the flight but also hotel costs, car rental fees and other incidental expenses. Initial deposit is 10%, with up to 12 months to pay the balance. Interest rate is 13%.

► Federal Aviation Agency has awarded contracts to the Hindustan Technical Development Center and Wilefox Electric Co. for the development of radio beacon transponders for use in business and private aircraft. First models will weigh about 34 lb. and will cost, under production, about \$1,000.

► Czechoslovak Airlines is using Russian-built B-18 turboprops transports on its route between Prague and Baghdad via Athens and Istanbul.

► Braniff Airways and Eastern Air Lines began interchange service last week between New York and Bogota, Colombia, via Miami and Panama with Braniff's Boeing 767-210B refueling equipment. Braniff will fly the aircraft as the Miami-Bogota segment of the route. Eastern on the Miami-New York leg.

► Lithuanian Airlines has signed a letter of intent to buy two Boeing 720B turboprops transports for delivery in December, 1981.

► Delta Air Lines is now operating an all-new schedule out of New York's International Airport. The airline is offering 10 schedules daily using Douglas DC-8 and Convair 880 turboprop transports.

► Midwest Airlines will equip its five Convair 440s and seven Convair 240s with RCA AWD-50 weather radars. Installation begins this month, will be completed by January, 1982.

► Civil penalties totaling \$1,000 have been paid in the Federal Aviation Agency by seven passengers charged with violating publication prohibiting drinking from private liquor supplies aboard scheduled transports (AW June 13, p. 49). FAA imposed a \$200 compensatory penalty for each violator. Fines can be as high as \$1,000.

► Development Loan Fund will lead the government of Chile \$10.5 million for the construction of an international commercial jet airport at Santiago. Airport will cost off for a 10,000 ft. runway designed for single-plate loads of 62,000 lb.

► Ansett-A.N.A., Australian airline, has ordered two Fokker F-27 Friend ship turboprop transports to bring its Friendship fleet up to a total of eight. Delivery is scheduled for early 1983.

► Original Boeing 707 turboprop prototype, the "Dash eight," which celebrated its tenth anniversary on July 15, is still being used extensively in the 707 series product improvement program. Plans now are undergoing a heavily instrumented program of investigating various high-altitude devices.

SHORTLINES

► Air Transport Assn. has revised its "Standard Method of Estimating Composite, Bureau Operating Costs of Transport Aircraft." Latest edition is the third revision of the report, which was first published in 1966.

► Air Line Pilots Assn. has filed a suit in Federal District Court in Chicago asking that Federal Aviation Agency not approve a proposed alliance with FAA inspectors on the project flight. Suit was filed in a cross-complaint resulting out of an injunction obtained by American, Pan American and TWA requiring pilots to accept flights on which the flight pilot was displaced.

► Alitalia, the Italian airline, has transferred its third Douglas DC-8 turboprop transport on its transatlantic route, resuming jet flights in a daily service between New York and Rome. Carrier plans to have an all-jet service on the route by Aug. 1, with 14 flights weekly.

► Air France has been named guardian at North America for Transports Aériens Internationaux-TAI. Air France will handle all the privately-owned carrier's sales, traffic and promotional activities in the U.S., presenting TAI's Los Angeles-Tokyo route and the around-the-world route operated by coexisting services of the two companies.

► American Airlines and Continental Air Lines will begin Boeing 707 turboprop transport service between Los Angeles, El Paso and Houston Sept. 3. Under the interconnection agreement, flight equipment will be supplied by Continental on the first six months of the service and by American, which will fly the last six months. American's routes will fly the schedules between Los Angeles and El Paso, with Continental crews flying over the balance of the route.

► Independent Airlines Assn. will request CAB permission to enable its members' vehicles to provide round-trip charter flights for \$32,575 in Lockheed Constellation equipment. Passenger's round-trip fare would average \$222.

► Pan American World Airways will be flying Boeing 707-320 turboprop transport service from New York to Rio de Janeiro Aug. 3. Flight time on the 4,875-mile trip, which includes a 90-mile stop at Tumaini, will be 9 hr. 45 min.

► Panair has introduced a Douglas DC-7 all-cargo service from Miami to Georgetown, Esq., La Paz and Cochabamba on a weekly schedule. The service replaces a DC-6A all-cargo operation started earlier this year.



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MEMO TO MICHAEL:

Your recent letter to the company has been brought to my attention. I am particularly interested in this paragraph.

I am in the fifth grade at Brown School and am very interested in aviation. When I grow up I want to be aeronautical engineer if my mother will let me.

Sincerely,

Charles W. Kaman



IN
NATIONAL
DEFENSE

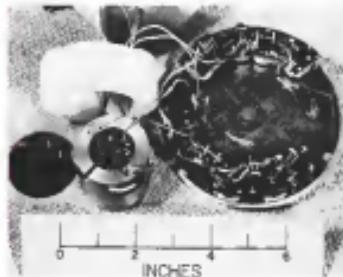
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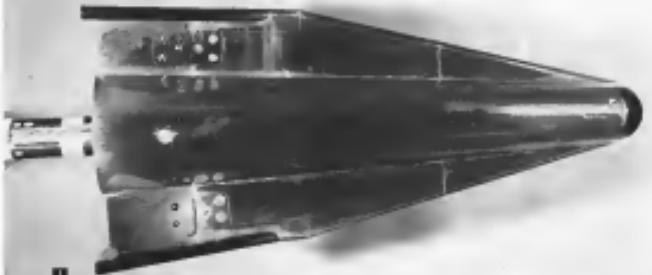


Strongarm sounding rocket is being fired at Wallops Island, Va., as a series of atmospheric electron density experiments which began last fall. Above: Kaman Research Laboratories rocket (left) is composed of three stages: first stage, Nike Apogee booster second and third stages, modified Rocket Research stage and solid-booster Segrand first stage. Enhanced shroud nose cone (right) carried 37 and 145 mc. transmitters in its modular base, with external stations using as antennas. Circular objects at top and center of nose cone are intense timing capacitors BRL developed SPOT system (below) to track and photograph the flight.

Strongarm Launched to Ionosphere For Electron Density Measurement

Roku transmitter on Strongarm payload included 37 and 145 mc. transmitters (right) and a master oscillator (center, lower left).





CONFIGURATION ABOVE resembles the one chosen for the Dyna-Soar vehicle and the only full Aerofit hypersonic glider proposed.

USAF Builds Capability for Hypersonic

By J. S. Betz, Jr.

Washington—Air Force has created a capability to manage the technical development of winged hypersonic vehicles, previously by playing a major role in compiling the necessary engineering data through trade contracts and internal applied research programs.

As Force's present purpose in developing hypersonic aircraft is to allow a complete return to the traditional Air Force-commander relationship without the technical difficulties which are expected during the development of ballistic missiles, the traditional relationship is which

technically competent Air Force personnel responsible for operational design and development work on new weapons has been abandoned in only one way—namely—the crash program to develop long ballistic missiles. Ballistic Missile Division was set up in the Air Force's management agency for this program, and its technical advice came first from Rame-Worthington, and then the aerospace Space Technology Laboratories.

National Aerospace and Space Administration and several research foundations and universities currently are making major contributions to the understanding of hypersonic aerodynamics and heat transfer without direct Air Force support. But many such organi-

zations who are assisting the USAF effort by developing design methods for hypersonic aircraft are not included.

Development

zations who are assisting the USAF effort by developing design methods for hypersonic aircraft are not included.

Wright Air Development Division is the Air Force group charged with technical management of the Boeing Dyna-Soar orbital aircraft which is now under development. This division is also the Air Force's management agency for advanced hypersonic aircraft which are still in the preliminary and conceptual design stage. To perform that advanced design function, WADD is sponsoring a wide variety of internal and contract applied research programs intended to give the organization an in-house capability to perform the complete preliminary design job for winged and unpowered hypersonic vehicles. This in-

SPACE TECHNOLOGY



MODELS of hypersonic vehicles are tested at very high angles of attack.



EFFECTIVENESS of control surfaces on hypersonic boost glide vehicles is one of the subjects of the Air Force Lookout study at very high speed aircraft configurations.



POSITIVE DIHEDRAL on a hypersonic wing (model No. 4) gives vehicle a "steep" look. This increases the aircraft's stability, reduces stresses on the wing and reduces the location of maximum heating from the wing leading edge to the side along the center of the lower surface. Shown here (model No. 3) has been investigated for possible application in lifting roles.



INCREASE in nose Mounting lower the maximum temperature on a vehicle at the expense of aerodynamic efficiency.



VARIETY OF CONFIGURATIONS studied for hypersonic flight is illustrated by the constant span chord-rised model at the left. It might be possible to reduce high temperature area at the expense of poor lateral stability with this shape. Many other wings (above) have been tested.

TIROS
GROUND
STATIONS...

Over 23,000 informative cloud-cover pictures have been received from TIROS I since it was launched on April 1. In one month the satellite had completed 6,000 orbits and traveled 21,000 miles in space. The TIROS I ground stations have been most pleased at its performance, but that the complex problems of obtaining and storing, as well as signal reception and processing, have been successfully overcome. Like the satellite, the ground stations were designed with the help and support by RCA Astro Electronics Division under the supervision of NASA and technical direction of the U.S. Army Signal Corps.

Major components of some of the four ground stations include:

- Four TV cameras and four beam splitter modules used to diversify reception to minimize signal fading.
- A programmed switch which permits different combinations of operating modes, and a 300 watt command transmitter.
- A TV camera to display the picture signal for the automatic recording cameras. The camera is equipped to make color positive or negative film.
- An index and one angle computer which assumes an index number and an angle indication for each picture, used for geographical orientation.
- An automatic switch which picks up the earth horizon signal for spin axis position computation.



The Most Trusted Name in Electronics
RADIO CORPORATION OF AMERICA

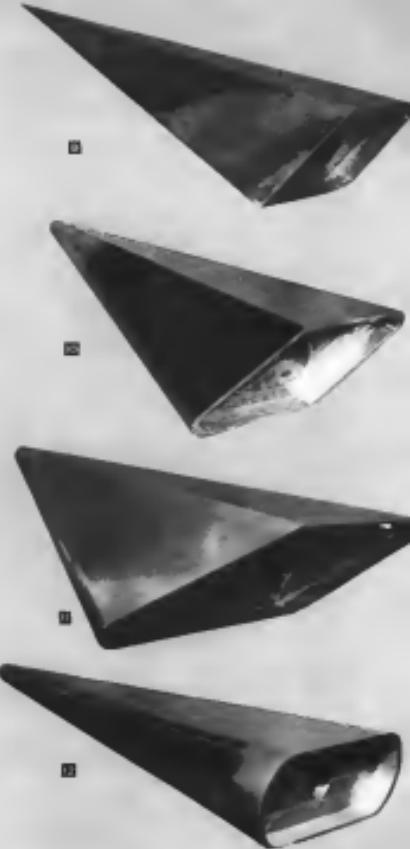
house design capability is regarded as the key to good technical management. Aeronautical and aerospace programs are managed by WADD, which is supposed to perform management functions and provide technical support. Management of these programs is facilitated by WADD's Directorate of Systems Management, and its Directorate of Systems Engineering in the technical advisory group. Dysfunctional dyslexia is being remedied by these offices, as in the B-52, GAMBIT, Skunk Works-launched ballistic missile, the GAM-72 Green Quest atomic missile, and all of the other Air Force weapons in development as aerospace systems.

The third major WADD subdivision, the Directorate of Advanced Systems Technology, is the group which must be converted to use the state of advanced technologies and has been directed to maintain a capacity for the complete preliminary design of winged hypersonic vehicles. An especially close interchange of information between the three directorates is maintained in the case of the Dyna-Soar program, which is just out of preliminary design and will provide more accurate information on hypersonic vehicles after it has made a few flights than all of the research performed to date.

Typical of the applied research programs supported by the Directorate of Advanced Systems Technology are three studies:

- Hypersonic configuration study by California Division of Lockheed Aircraft Corp. Object of this study is a design manual containing analysis techniques for predicting the aerodynamic characteristics of hypersonic vehicles over a large speed range. The research portion of this study is represented by about 500 hr of wind tunnel test in the Viscous Flow Dynamics Facility at the Arnold Engineering Development Center over a Mach number range from 2 to 15.
- Study of flow characteristics around a lifting body during re-entry into the atmosphere at high speed conducted by General Applied Sciences Laboratories, Wertheim, N. Y. Main problem in this study is associated with the effect of the boundary layer flow around a body in the external hypersonic flow outside of the boundary layer. This effect is of special importance in determining the flow interference between two or more bodies on a hypersonic vehicle such as the wing, fuselage and stabilizing fin. Experimental portion of this study is being conducted in an AEDC facility in the Mach 3 to 25 range. Ultimate objective of the study and many others of a similar nature which are supported by WADD is a simple design manual which will allow aerodynamic heating and pressure distribution over a hypersonic vehicle to

WIND TUNNEL TEST DATA from the family of models shown can be used to determine the effect of leading edge blunting on the aerodynamics and heating characteristics of hypersonic vehicles. Model No. 9, with very sharp leading edges, represents one extreme, while the large rounded wing leading edge on model No. 12 represents the maximum curvature which would be considered on a practical vehicle. Test data on this family of models will also contribute to the study of dihedral effects. Wings shown above are only a small portion of these tested at Tafelbahn.





**The Republic F-105D streaks to a new world speed record...
powered by a Pratt & Whitney Aircraft J-75 jet engine**

On December 13, 1969, the Republic F-105D fighter-bomber raced over the Mojave Desert at 16,000 feet. The course was a 62.4 mile racetrack. With a nose-down of 41 degrees below zero, the Air Force F-105D cleaped through the climb course flight to establish a new world record of 2,216.47 mph. Its highly advanced electronics, radar, and instrument equipment enable the F-105D to perform accurate air-to-air and air-to-ground. Its speed and power make it one of the most versatile aircraft in history.

The jet engine that powers the F-105D is the Pratt & Whitney Aircraft J-75. This same engine also powers Convair's F-106 all-weather interceptor, which ranks it as a new world's straight-away record. Over the years, the Pratt & Whitney Aircraft J-75 and J-79 jet engines have broken virtually every major flight record.

PRATT & WHITNEY AIRCRAFT

Edgar A. Gorham
A DIVISION OF AVIATION VACUUM CORPORATION



he predicted rapidly with the engineer ing aircraft used today for supersonic aircraft.

• Optimum flight paths for winged reentry vehicles which will minimize the aerodynamic heating problems are being investigated by the Convair San Diego Division. In this path, theoretical study, the modulus of turn-over is being used to calculate the angle of attack schedule to be followed by many types of winged vehicles re-entering along many different trajectories. These calculations are being made on an IBM 704 computer.

• Study of the stability parameters particular to hypersonic flight is being made at Flight Systems Laboratories at Buffalo, N.Y. Research scientist Fredric number, Math member and the other lead has stability parameters which have made it possible to this point for small scale model tests to be used in the design of large vehicles not yet adequate for hypersonic speeds. The high temperatures of hypersonic flight cause physical and chemical changes in the air. An extensive mathematical description of hypersonic flow is much more involved. There is a description of hypersonic flow.

• An edge-of-freeflow flight path analysis for hypersonic vehicles is being conducted by McDonnell Aircraft Corp., making use of an optimization of an input of an IBM 7090 digital computer. This program is set up so that a safe entry of problems may be solved quickly, from then, avoiding point mass objects with two degrees of freedom to the most complicated use of degree-of-freedom studies of winged vehicles so which autopilot responses and stability margins effects are taken into consideration. Results of this work will be published in a WADD report which will discuss shock, computation methods for vehicle performance along any trajectory with reasonable navigation accuracy and to make error and impact time analyses about unmet flight paths.

• Free flight model test program is being managed by the Flight Branch at WADD. In this program, large scale models of winged hypersonic vehicles will be tested in March 1970 by Air Force TS-609A facilities, which will be similar to the NASA Scott vehicles. The first of these models will be made within a year. They are now in the preliminary design phase. Two types of models will be used aerodynamic models for external configuration studies and structural models which will cover full scale structural sections from hypersonic vehicles.

Flight Systems Laboratories has the preliminary design contract for a test aircraft. McDonnell has a similar contract for the flight test aircraft. Models No. 10 has a nose fairing cylinder. Convair fairings with less resistance and drag are used on Models No. 14 and 15. Model 16 has a built up flat-sided fairing, and the fairing on Model No. 17 extends below the wing. Various degrees of leading edge bluntness also are studied.



HYPersonic GLIDERS which have highly loaded, isolating skin to protect the fuselage from heat damage. High temperatures will damage the flexible thermal insulation fibers and the structural aluminum. Models No. 10 and 14 are demonstrating the basic concepts of providing the volume of a high aspect triangular wing. Model No. 15 has a nose fairing cylinder. Convair fairings with less resistance and drag are used on Models No. 14 and 15. Model 16 has a built up flat-sided fairing, and the fairing on Model No. 17 extends below the wing. Various degrees of leading edge bluntness also are studied.



Within two years Ford will land a space vehicle on the Moon

A 300-pound Lunar Capsule containing scientific instruments will soon make a "rough" landing on the Moon. It will be carried by a larger spacecraft to a location about 25 miles from the Moon's surface, then released. A retro-rocket will cushion its impact. The Lunar Capsule will transmit vital scientific data back to Earth for a month or more. This unique space vehicle will be the product of Ford Motor Company's Aeromutronic Division.



THIS LUNAR CAPSULE, now under development for NASA's Jet Propulsion Laboratory, is one of many space-oriented programs now under way at Aeromutronic Division of Ford Motor Company.

These programs—and many others related to advanced weapon systems and computer systems—are being carried out at Aeromutronic's multi-million dollar Engineering and Research Center, in Newport Beach, California. They emphasize Ford's rapidly growing role in meeting the needs of science and defense in the Space Age.

A booklet describing Aeromutronic's accomplishments and capabilities is available to you on request.

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months long and on the Boeing Dynaliner and then will provide the first large scale hypersonic flight data. If the model flights are successful and their instrumentation and telemetry systems function properly, they will produce the best data available for the design of hypersonic vehicles.

It is possible that this large scale information will solve the problem of finding the correct stability parameters to use in hypersonic flow. If this can be done, as early as 1968, there will be available a large amount of the necessary hypersonic wind tunnel data which will have been made to date, but more extensive still surround the reentry portion of the data, and it is not clear exactly how it should be applied to the design of hypersonic vehicles.

Model aircraft will be located to attain a flight speed in the TS-807A which are called aeroballistic missiles by the Air Force, and it is possible that they will fail and disintegrate somewhere near the end of their flight histories.

Internal applied research programs at WADC include aerodynamic heating investigations on highly swept wings at bank angles of attack ranging from 90 deg. to plus 90 deg. Studies are being carried on wings flying bodies for hypersonic vehicles.

Detailed studies are also sponsored on the low-speed flight characteristics of hypersonic vehicles, possible uses of magnetohydrodynamic cooling systems at very high speeds, efficient airfoils for hypersonic speeds and many other design areas pertinent to very high speed vehicles.

Solar Power Unit To Generate 100 w.

Washington—Prototype satellite solar power unit designed to generate 100 w. is being built by Hamilton Standard Division of United Aircraft. The Wright Air Development Division is responsible to the team for ground test facilities.

Folding generator will mount approximately 900 aluminum reflectors 4 in. in dia. over a 180 sq. in. area. Reflectors, assembled in groups of 15 on aluminum tubing, will focus solar light as radiation collides in their center. The rays heat oil circulated to one end of a thermocouple, while temperature rises to 1,800°, while the temperature at opposite end, which is cooled by radiation from the reflector's back surface, rises to 1,600°. Temperature difference causes a voltage flow.

Solar generator capability eventually will be increased to an output of 1,500 w.

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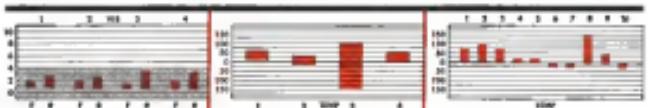
A landmark in engine communication progress is the Bendix® Temperature-Vibration Monitor which simultaneously displays the findings of 40 temperature and 4 vibration sensors strategically located on all 4 engines of a turbine-powered aircraft. This data is presented on the flight deck of the aircraft in bar graph form so that it can be continuously monitored and easily read.

The average displacement of 8 vibration sensors is displayed continuously on the lower exhaust air tube with the top of the bar graphs indicating vibration displacement on the grid scale. The continuous monitoring of vibration immediately indicates engine anomalies on the jet engine.

The temperature analysis simultaneously mounted with the vibration graphs will locate faulty burners, bad combustion distribution and plugged nozzles or any unusual heat or cold

conditions around the turbine engine exhaust. The temperature display in the "all" position presents maximum and minimum temperatures on the upper exhaust air tube continuously for the four engines as reference to a temperature datum set at by the operator. The individual engine temperatures can be displayed as 20 bar graphs whose definition can be read on the tube scale as a deflection above or below the temperature datum, and individual deflections may be accurately and easily read from the digital read-out scale.

The equipment, initially designed for the BOAC, is applicable to all jet and turboprop aircraft powered aircraft. The equipment for the four engine installation is approximately 30 lbs. and includes the Temperature-Vibration Monitor pictured above and a remotely mounted 15 ATR data box.



Vibration indication for four engines with front and rear pickup on each. Height of bar indicates total vibration displacement.

Temperature Indication for four engines. Height of bar indicates maximum and minimum temperature above or below temperature datum reference.

Scintilla Division
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Load Cell to Be Used in F-1 Rocket Testing

Type C-1C load cell built by Esterline-Aero-Hamilton Corp. will be used to validate a dual-load cell shock load detector weight and thrust forces of the Rockwell F-1 rocket engine. Future short engine test flights will be conducted at National Bureau of Standards, Washington, D. C., utilizing four 300,000-lb-capacity proving rings using a load cell used to validate the Type C-1C cell. A compressor unit weighs about 1,500 lbs., is 25 in. dia.

PRODUCTION BRIEFING

Lockheed Foundation for Medical Education and Research has a \$175,000 Allis-Chalmers Corporation contract to explore the possibility of establishing an AEC biological research laboratory in Allentown, Pa. All rights for certain Rockwell-designed engines in continental Europe will be held by Allis-Chalmers. All rights under U.S. rights for AEC's engines

U. S. Air Force has ordered 15 Cessna 172 aircraft for utility and transport missions in the Congo. 172's will be fitted with dicing and anti-icing equipment for all weather operation. Deliveries will start in December.

Aerospace Group, Avco's 300-annual-aircraft backlog from National Aeronautics and Space Administration's Wallops Station are boosting 180% payloads to altitudes of 150 mi for satellite and solar observations.

Westinghouse Electric Corp. is building an air-pump nuclear powerplant being developed by Martin Co.

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And even while today's countdowns go on, plans for tomorrow's assault on space are being made. At Rocketdyne, engineers and scientists are investigating such advanced forms of propulsion as ion engines, nuclear engines, plasma jets, and magnetohydrodynamic engines. Meanwhile other groups are at work on high energy liquid and solid propellants, and dramatic new devices for both liquid and solid propulsion systems.

Rocketdyne, a 12-year pioneer in rocket technology, was first with power for America's long-range ballistic missiles—first with power for Outer Space.



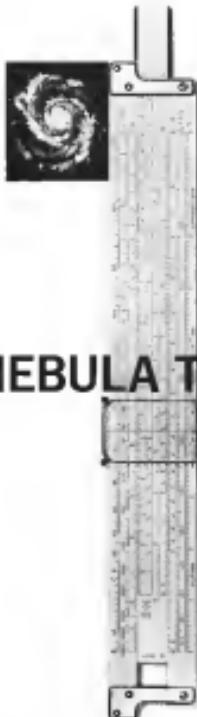
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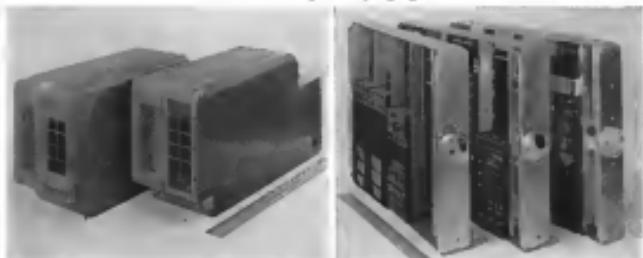
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AIRCRAFT VOCODER, developed by Hughes Aircraft for use on the B-70 and B-52B, permits 63 reductions in bandwidth to automatically encrypting of voice communications with an increase in bandwidth (3dB). **Ground-based vocoder** (right) for point-to-point communications, provides duplex operation, weight 200 lb. Vocoder deconverts speech into logic elements which can be transmitted as digital logic, then used by receiver to reconstruct original speech.

Vocoder Increases Channels, Security

By Philip J. Klem

Washington-Steel, light-weight, high-power vocoder (inter-terminal), which allows a natural or synthesized speech signal for a voice communications system, provides automatic encrypting for military security, was described here during the recent Military Electronics Conference.

Vocoder techniques are being used in field use in caused deep space probe and lunar explosive devices for reduced bandwidth with cut transmitter power requirements.

New vocoder was developed by Hughes Aircraft Co., under Wright Air Development Division, for use on the North American B-52 and F-105, under a program known as Project Qualitative. The object was to provide dependable, secure language in ground communications. Strategic Air Command plans to evaluate the Hughes vocoder for possible use in existing bombers to increase security of voice communications.

Airborne Vocoder

The new Hughes airborne vocoder, which can encode voice in either analog or digital format, will use only 60 lb., measure 1 ft. 6 in. and consume less than 100 watts. Hughes' A. J. Stromness reported here. (The report was co-authored by E. C. Steckloff.) The unit is designed for simplex operation. A duplex model vocoder designed for

ground-based point-to-point use, weighs 200 lb. and includes circuit both for compressing and degrading speech for transmission as well as converting digital information back into synthetic speech.

The airborne vocoder, reportedly developed by Hughes, up to 98% of the individual speech was intelligible, which should provide an overall system intelligibility of about 93%. Stromness said. *Postscript* intelligibility is higher than that of individual words because of inherent redundancy in sentence structure.

Speech Compression

First vocoder was developed in the late thirties by Bell Telephone Laboratories as part of a program aimed at better understanding of speech and some efficient methods of transmission.

In recent years, the military services have sponsored considerable research in the field of speech compression, aimed at reducing the bandwidth required for voice transmission, in order to squeeze more channels into the radio spectrum and/or to improve security.

Naval Research Laboratory, in Aug. 1955, p. 3503.

Normal speech has a bandwidth of about 3,000 cps, required for voice representation of good intelligibility. Encrypting is required, voice can be converted into digital format which requires a reduced bandwidth in about 32,000 cps, according to Stromness.

The Hughes vocoder utilizes the

bandwidth required for voice transmission, which is between 200 and 500 cps, permitting use at voice rates as many voice channels as conventional (unencrypted) voice communications. Encrypted vocoder voice can be transmitted with a bandwidth of over 3,000 cps, the same bandwidth needed for conventional unencrypted communications.

Secure Speech

The human voice, Stromness said, consists of two basic types of sounds: * Viced sounds, or vowels, produced by vibration of the larynx under pressure of air from the lungs.

* Unviced sounds, or consonants, produced by one or more of the lips, tongue and oral passage.

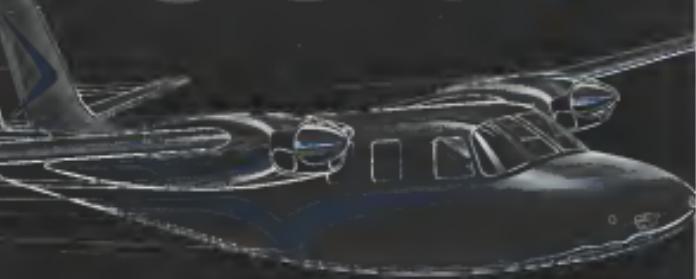
The voiced sounds, or vowels, are the predominant carriers of information in human speech, while the unvoiced sounds give speech the characteristics which make it possible to distinguish one person's voice from another's.

The voiced sounds consist primarily of harmonics of the frequency at which the larynx vibrates, usually at 150 to 150 cps, for men and as high as 250 cps for women.

The unvoiced sounds have discrete harmonic frequency patterns, being composed of frequencies randomly distributed throughout the spectrum and varying as amplitude according to the sound being produced. Stromness said in most instances, voiced and unvoiced

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means do not occur simultaneously in human speech.

There are several different approaches to the design of a vocoder. The approach used by Hughes is called "fixed-channel analysis." In this case, a series of 12 frequency filters, called "voiced sources," are decomposed into 12 segments of the audio spectrum from 200 to 4,000 cps, also having passed through a voice-operated gain adjustment device (VOCADO), in which speech volume is automatically adjusted to a uniform level.

The bandwidth of the individual filters varies from 160 cps at the low end of the spectrum to 750 cps at the high end.

The output from each bandpass filter passes to a corresponding speech analysis filter, which measures the power density of the sound in its assigned frequency range. The output from each speech analysis filter is fed to an electronic converter, or tone multiplexer, which converts the magnitude of each analysis output in time sequence, once every 21 milliseconds.

The output of the multiplexer can then be transmitted as pulse amplitude-modulated signal (PAM), or converted into binary form, if desired.

Receiving End

At the receiving end, the process is essentially reversed to synthesize sound that resembles human speech. These are the three members of speech: tone, form and bandwidth, each covering the four segments of the spectrum in the transmitter vocoder. An "idle energy source," referred to as the "base generator," provides the energy for voiced or vowel sounds, while another called the "line generator" supplies energy that produces the unvoiced, or consonant, sounds.

The amplitude of signal received from the transmitter vocoder for each segment of the audio spectrum causes the appropriate synthesizer to produce a sound of comparable power intensity. The outputs from all 12 synthesizers, after passing through filters which act as voice-unvoiced harmonics, are then combined, amplified and fed to a loudspeaker.

In any instance when the speech is predominantly unvoiced (unvoiced), a switch in the transmitter vocoder, called the "punch extract," is activated.

The unvoiced signal to the receiving vocoder causes it to automatically disconnect its "base generator" and substitute a "line generator" which applies the random frequencies contained in the unvoiced sounds.

At such times as the human speech contains both vowels and consonants

consonants, the combination is treated as if only vowels were present and the base generator is not activated.

The output of the transmission vocoder can take the form of pulse amplitude-modulated signal, or the level of each of the 12 spectrum subbands is defined by one of eight levels, while the peak extrater energy is quantized into 64 amplitude levels.

Modulation Techniques

Normal voice can be digitized directly using pulse code modulation at digital rates, but such techniques require 20,000 to 30,000 bits per second for adequate quality. Shostakov said. This high rate is not address economically, particularly for only one voice connection.

With the vocoder, its output can be converted directly into a digital bit stream which requires only about 2,000 bits per second data rate. Furthermore, digital error rates as great as 1-2% have negligible effect upon speech intelligibility when they would cause up to 10% of the characters in an ordinary teletype system to be in error, according to Shostakov.

Various types of phase modulation or frequency modulation can be used to transmit the digital bit stream. The choice of the modulating technique and its parameters depends upon the reliability of voice communications as the high frequency band in the face of both natural and man-made disturbance, Shostakov indicated.

Shostakov said that any desired level of voice transmission of speech signals can be achieved through use of digital bit stream transmission in voice.

System Savings

For point-to-point communications, a number of standard bit stream transmitters can be time-multiplexed with a sufficient margin in spectrum, bandwidth and cost, according to Shostakov. Using the existing state of the art, it is possible to transmit 12 fully encrypted speech channels with a substantially higher average bit rate power utilization facilities that now provide only 24 unencrypted voice channels, and with much less complex multiplexing equipment, Shostakov said.

Using the new vocoder design, he achieved word transmission rates of 15 to 30%, giving even perfect speech intelligibility, according to Shostakov.

The present Hughes airborne vocoder is fully automated, except for one subsystem which serves as a power source. Airborne units use 250 silicon transistors and 915 diodes, which are able to operate up to 100°C temperature. Ground-based duplex vocoder uses 380 silicon transistors and 1,125 silicon diodes.



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Semiconductor Emission Studies Aim at Better Electron Tubes

By Harry Miller

Dr. Minnearth, N. J.—More efficient electron tubes are the goal of a series of research studies using electron emission from semiconductor being conducted here at the U. S. Army Signal Research and Development Laboratory and in a few other laboratories throughout the country.

and the catalyst. Semiconducting resin powder to be effective electron source for ionizing oxygen atoms gives a better understanding of plasma etimation from single crystallized polystyrene semiconducting and the mechanism responsible for it. This could explain the conventional heating methods along a wood burning. The heated cathode is the devinum source which makes tube operation possible. It also has a wasteful side. Heating requires power which adds overhead in weight in space and the heat generated must also be removed.

Nature Reviews

For this reason and the desire to do away with the heater filaments resulted a first series of tube failures, ascertain for some time pondered over and sought some of insulating electron tubes by using unheated or cold cathodes, coated with materials like polycrystalline hot semiconductors.

Although the major portion of a cor-

recent series of government-supported studies of electric erosion at the Evans Area of the Saginaw Lakeshore in north West Michigan and elsewhere are not now seeking new devices but rather a fundamental understanding of erosion phenomena, some practical achievements in a matter of record.

Cold Cathode

Fighters would sign this letter to the editor along with an annotation. Tong Soi Electric Co. of Newark, demonstrated the results of several tests effort—the cold cathode tube (CAT) Feb 2, 1979, p 641. The cathode of this de-

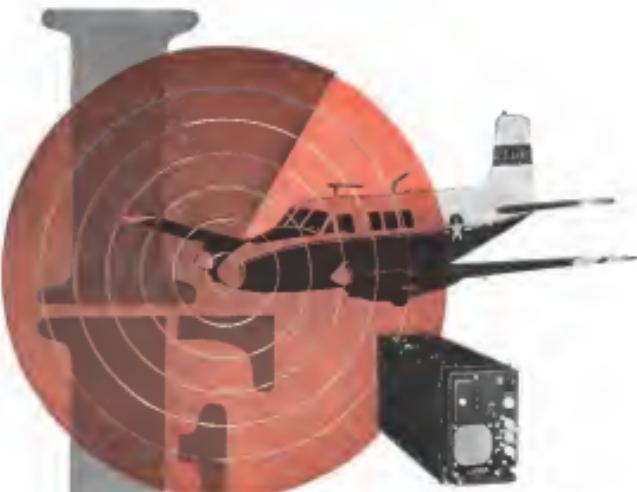
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Winter 2003

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Wilcox is producing these airborne units in quantity and on schedule.

The AN/APX-44 features minimum size and weight, modular construction, a crystal-controlled oscillator and synthesized transmitter. It is indicative of the electronic systems capability and experience of Wilcox.

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ber of semiconductor—Glim, germanium, silicon carbide and diamond among others. Their observations led to specific advantages of the potential advantages of hybrid electron tubes, with the semiconductor junction diode replacing the normal cathode, which might be beyond this early, explosive research.

Research Efforts

The Signal Corps and to a lesser degree, the Navy Bureau of Ships are now supporting a number of complementary research efforts regarded in the first steps in this direction. The Army's effort, according to Dr. Dennis Heimark, and Louis N. Hirsch, at Etron, is proceeding along two lines. These are:

- Further study of cold-cathode tubes and the phenomena, will not thermally exhaust, before electron emission from polymerized-filament materials.
- Study of electron emission from single crystal pn junctions.

At present, the relation between the two emission phenomena is not known. Both are also some type of internal field emission, Heimark says. In the one instance, an external electric field imparts sufficient energy to electrons for them to escape over the surface barrier. In the other, the emission mechanism involves a form of internal field emission and, possibly, Heimark says, the same mechanisms responsible for emission from pn junctions others in protecting emission in the cold methods.

In the area of electron emission from single crystal pn junctions, the Signal Corps is conducting fundamental studies of what it calls "hot" electron emission under a two-year, \$168,000 contract with RCA Laboratories in Princeton, N. J.

Hot electron emission relies on the heating of electric glass and not the crystal lattice itself as is done in normal filamentous emission.

Density Increase

As part of this work, the company has reproduced and utilized earlier work with pn junction electron emitters. RCA, however, increased the density of electron emission and the total current emitted from a junction by drawing new techniques. In doing the junctions, the company has found that the junction layer is thicker which aids in a barrier, preventing electrons from escaping from the semiconductor.

Uncoated silicon junctions cost fractional micrograms, currents under certain testing boosted this by several orders of magnitude. Now silicon junctions are stored on a pile bank before the crystal lattice heats up and electron emission drops. These pn junctions indicate, Heimark says, that a high order of magnitude emission



**General Electric can solve
 your special heating problems**

Whatever your thermal conditioning problem, General Electric can supply the answer. We have heating products with a high degree of reliability. Here are good reasons why:

GE has demonstrated the market for a high temperature plastic material.

GENERAL ELECTRIC EXPERIENCE in specially heating dates from World War II. Since we learned much about heating plastic materials and ceramic oxides. We are now producing valuable heating equipment for today's aircraft and missiles. Some examples: we are currently working on aircraft applications for solid-state propulsion, batteries, electronic components, hydraulic systems, and airborne cameras. And these products can be molded or tailored to any shape desired.

SP-10-2474 MATERIALS, composed with an extensive design and fabrication experience, enable us to build durable, lightweight heaters that will withstand severe vibration or shock. These materials are flexible over a wide range of temperatures, and possess a high degree of resistance

to water, oil, air, and chemicals. The literature demonstrates the market for a high temperature plastic material.

FOR MORE INFORMATION, contact D. R. Barbour, Manager—Engineering, Specialty Heating Products Section, General Electric Co., Coxsackie, N. Y. (Phone Coxsackie 6-5531), or mail coupon.

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Heavier
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Much!

STRATOPOWER's new, light weight axial-piston hydraulic motor

...packs more power per pound!

The .3 cubic inch production model shown here, weighs only 1.8 pounds... yet delivers a whopping 9 horsepower at 10,000 RPM.

STRATOPOWER motors are available NOW in sizes from .45

to 45 cubic inches... built to our specifications or yours.

Tell us about your requirements. Write to Department S-200V

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Qualified engineers in hydraulics and control systems are invited to investigate their potential in the STRATOPOWER hydraulics. Please contact: R. W. Doherty, Personnel Manager.

from efflux and generation pressure is possible.

RCA is trying to hammer out a complete theory to explain plasma rotation. One interesting aspect of its work is the fact that the most recent observation of field aligned plasma rotation (light focused on a lock-based silicon air generator) produced electron emission as well and that expected from electron emission. Besides offering another fuel for studying electron emission, this may give the possibility of obtaining longer wavelength infrared plasma detection.

In addition to the work at RCA

Systems Corp. of America, Bedford,

N. H., another major effort is a

useful theory of magnetohydrodynamics

rotation under a \$100,000

Naval Bureau of Ships contract. Nuclear

is testing at large band gap semiconduc-

tors which have the theoretical ad-

vantages of reducing the effect of elec-

tron afflux—which might make the

renewal treatment unnecessary—and a

more stable resonance heating.

Magneton Guide Type

Since the initial demonstration of

solid cathode tube development has

continued at the research and development type

of tube and resonator. Use of cold cathode

resonators made cathodes in electron guns

far cathode less likely for large dimensions,

according to Dobrochuk. The

cold cathode ion beam used in combination

with secondary emission, the

phenomenon. One recurring and

bothering problem is cold cathode

emission, however, as the cold cathode in electron

resonators due to heating after short

operating periods. This can be over

come, Dobrochuk says. By proper pro-

tection design so that the cathode could be

cooled in room temperature after maxi-

mum heat.

Other respectable electron densities

in the neighborhood of 100 million

cm⁻³ are responsible to theoretical rea-

son, being achieved in the laboratory

heat.

The cold cathode also tends to be

more precisely in order to regenerate

more electrons after each thermal

ion cathode.

This is not an easy

problem, says Dobrochuk.

He says the problem is to

keep the electron gun

from overheating.

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INFRARED components instruments systems

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DEPTHS OF
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Boeing Studies Antenna Radiation

Boeing model of a Boeing B-52G jet bomber is used in measurement of radiation patterns given off by the aircraft's antenna (AIAW Apr 31, p. 181). With a radio way of Waltham, Mass., division, could be utilized around the world as rapidly as transmitted.

some properties, impedance, and other characteristics of cold cathode tubes at a location of different preparations of magnesium oxide and other compounds.

A \$75,000 two-year contract, awarded in and June to Philco, for the task of putting together a theoretical explanation of the mechanism involved in cold-cathode emission. Philco will conduct very little experimental work but is expected to design the experiments to determine the nature of the emission mechanism.

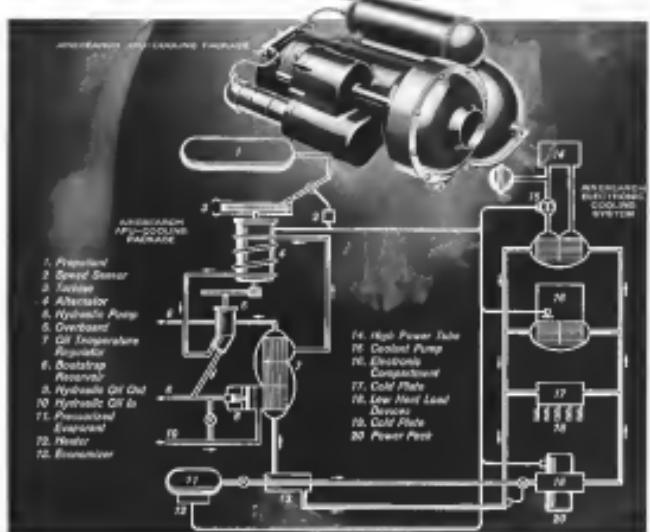
Total electron emission from magnesium oxide is well ahead of that from phosphorus. Emission densities from anodes appear to be on the rise, although it is hard to isolate the existing factors and therefore be sure of the density. Total emission, however, is still not as the class of the magnesium oxide type of cathode.

Some of other companies, including Westinghouse, are known to be studying electron emission from solids with a similar aim of eventually producing better electron tubes.

The Air Force are supporting work on external field emission conducted at Linfield Research Institute. According to Hirschfeld, external and external field emission can be related fundamentally. Emission densities obtained at Linfield with high external fields are appreciable, about 10^8 amp/cm², although total emission currents are not yet in the single region. Linfield will study multiple point emission under a two-year \$175,000 Advanced Research Projects Agency contract awarded in and June by the Secretary of Defense. It will attempt to determine the factors in multiple point field emission cathodes (two-point cathodes). Bellphoto's target of Linfield work, in the extent of \$75,000 annually, as well as Air Force support, is to be phased into the Signal Corps work.

A number of other companies, including Westinghouse, are known to be studying electron emission from solids with a similar aim of eventually producing better electron tubes.

Integrated accessory power and cooling system



meets the most advanced missile and space vehicle requirements

AirResearch has developed a single-system package for missile and space vehicle applications that provides the required cooling and heating load requirements in the face of decreasing size and weight allowances.

This integrated accessory power and cooling system supplies hydrazine power for cooling systems, 32000 BTU/HR. electric fireproof insulation power for insulation and control, and at the same time provides cooling loads for the APUs and all electronic equipment.

Operating in the missile or space vehicle environment, and in the trailer or satellite electronics applications, the expandable system is highly reliable and meeting load requirements in the face of decreasing size and weight allowances.

This integrated accessory power and cooling system supplies hydrazine power for cooling systems, 32000 BTU/HR. electric fireproof insulation power for insulation and control, and at the same time provides cooling loads for the APUs and all electronic equipment.

delivered more missile APUs than any other company, and is the leader in satellite electronics applications for aircraft, missiles and space.

AirResearch design and manufacturing experience in these two fields includes liquid and solid propellant APUs, hydrazine, liquid and solid insulation, and insulation systems, 3000 and 100 cycle alternators, cold plates, expandable and closed cycle, gas and liquid cooling systems, cryogenic cooling systems.

Please direct inquiries to Dept. Ing 101.



AirResearch Manufacturing Divisions

Los Angeles, California • Phoenix, Arizona

Systems and Components for: AIRCRAFT, MISSILE, SPACECRAFT, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS



Total weight of new Kinetics 1200 V.A. Inverter is only 18.4 lbs.

WEIGHT BY ELEMENTS	
Transformer	2.0
Heatsink	9.9
Semi-conductor	0.6
Capacitors	3.1
Filter	3.1
All other elements	6.2
Grand total	18.4
Components	14.0
Cases & base plate	1.7
Mounting hardware	2.7
Total	18.4
Dimensions	
Length	12"
Width, including base plate	3"
Height	4"

Important savings in weight and size have been achieved in a new single inverter designed and built by Kinetics Corporation. A typical inverter with a pure wave output of 1200 V.A., for example, weighs only 38.4 pounds and occupies only 200 cubic inches. Even more remarkable weight and size characteristics per K.V.A. can be achieved by units with 240000 watts.

These inverters are ideal for aircraft and missile applications in the range from 22 V.A. to 12 K.V.A. per phase. Kinetics static inverters may be constructed at any delta, or parallel. Each model will carry its own share of the load in parallel operation. No complicated or expensive bypass problems are encountered.

The reliable Kinetics design uses rugged silicon diode semi-conductor elements that are vital to every heavy

current. There are no moving parts, no moving parts, and no transistors in high current circuits. Efficiency exceeds 80% at full load, dropping to 70% at half load.

Class frequency control and audio-frequency degeneration is obtained with crystal-controlled digital read-back telemetry. The Kinetics design offers low-loss regulation. A high degree of reliability is achieved by the use of extremely rugged components and the lack of complex circuitry. Write or phone for more information. Kinetics Corporation, Dept. A-75, 460 South Colfax Avenue, Lakewood, Colorado 80401.



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CASE HISTORIES



ND integral surface gimbal unit shaft with precision bearing ball bearing assembly. The bearing assembly features a self-lubricating ball bearing. G.R. measures 0.016 inches from the hub.

ND Designs Reliability Into Sidewinder Rollerons!

CUSTOMER'S PROBLEM

With ever-increasing speeds of new fighter aircraft, the roll-on/off of this aerial-fired missile failed because they were subjected to environmental conditions more severe than those for which originally designed.

SOLUTION

New Departure engineers in conjunction with Naval Ordnance Test Station solved the problem by recommending a simplification of the original rolleron assembly. An integral gyro wheel and shield was designed that maintains critical rolleron reliability. What's more, the

new design reduces assembly, assembly time and inspection. And today, this same ND creative engineering and reliability can be found in more than twenty of America's major missiles . . . in airborne, guidance, propulsion and ground support.

If your product has unusual ball bearing demands, call in a New Departure Sales Engineer. He's the one who can provide you with Minimum, Instrument and Standard ball bearings . . . one that's sure to do the job for you! Write Dept. L-8, New Departure Division, General Motors Corporation, Bristol, Conn.



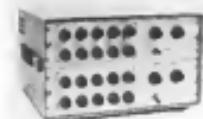
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BALL BEARINGS
precision reliability you can build around



-65P. A major supplier contribution of 1.25 million per unit, this provides several months of distribution. Loral, Inc., P.O. Box 188, Grand Rapids, Mich.



• Telemetry potentiometers, 300 track, have two independent channels, and can be read into angle, 0 to 360, or pitch allowing simultaneous adjustment of two canals. At 10,000 ohms per channel from standard units and pots up to 15,000 ohms per module on special order. Heat damping shunt can now furnish high power dissipation over wide temperature range. Dynavac, Inc., P.O. Box 120, Lincoln Blvd., Los Angeles 45, Calif.



• Switch and Relays, Inc., Model G-8 for use with stored logic and solid-state logic, has push button features under construction. Each provides approximately 16 of contacts ranging in size from 10 to 100 ohm change by connecting required units with plug-in cables. Completely automatic mounting and recording of tests can be accomplished from these, with them then be used with firm's resistance bridge potentiometers and output probe according to the manufacturer. Autotestronics, Inc., 3613 Artesia Blvd., Monrovia, Calif. 91016

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DORSETT telemetry components

Telemetry components designed and precision built by Dorsett Electronics will be selected specially instrumented Lockheed Agave Space Vehicles to be flown in the Discoverer Satellite Program.

Lockheed Missiles and Space Division is the latest in a long list of missile and satellite prime contractors to buy Dorsett Electronics components for advanced aerospace research programs.

Typical of the manufacturing equipment originating at Dorsett Electronics is the Model G-8 telemetry modulator. Requiring only 4 watts at 7 (amplified) milliamperes primary power, this all-silicon transistor unit provides excellent temperature stability for drift-free data. With its compact packaging, the Model G-8 is ideal when electrical power is limited, space and weight are critical, and environmental extremes are to be encountered.

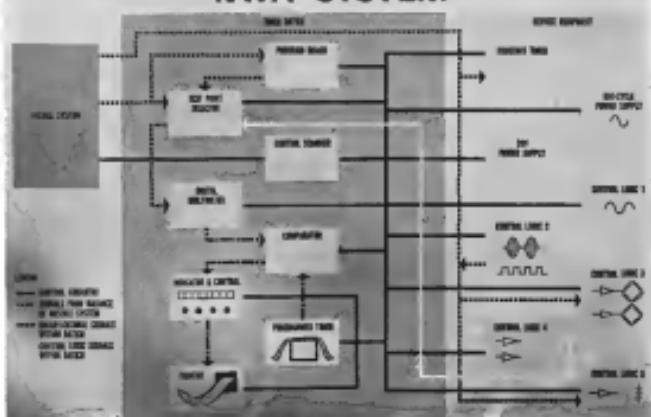
For more information on the products and capabilities of this fast growing team of telemetry specialists or on technical center applications, write today!

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119 WEST BOYD • NORMAN, OKLAHOMA • JE 4-3750

MISSILE ENGINEERING NWA SYSTEM



SATCOM equipment consists of flat panel or mast-mounted subassemblies and their AS-10 modules will be maintained at the Naval Weapons Annex, Charleston, S. C. The equipment is work checked except for addition of power supplies and a inspection flight.

New Polaris Checkout Devices Developed

By Ernest Hawke

Amherst, Calif.—Dixie automotive checklist equipment Inc. Navy's Polana fleet ballistic missile, supplier of about \$15 million of business to Northrop's Division of Northrop Corp., grew out of a basic unit designed for a particular application and was developed with \$70,000 of company money.

Lacking all of the specialized test components which must be associated with a specific application, Dornier's (Dornier) substrate-type intelligence check-out (SICO) was intended by Northrop to be tailored to a variety of systems by the addition of proper signal sources, monitoring devices and displays. The monitoring needed to adapt the basic SICO to a system to be tested is much less than that needed to develop a completely new set specifically for the system to be tested, according to Northrop officials.

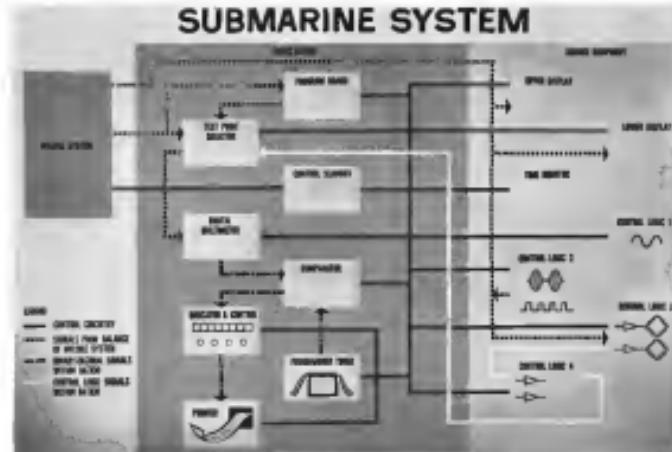
This advantage paid off in February 1999 when Navy Special Projects Office decided it needed a new Polaris check-

out systems quickly. After studying Dutton for two weeks to determine whether it was suitable for the job, Dutton left a contract in Narragansett to deliver a test unit back to environmental

standards five months later in Aug. 1. Since then Normous has acquired or data for numerous visitors to be installed on all George Washington class submarines, as well as 85-91 Poseidon class tenders and at the Naval Weapons Asy., Chantilly, S. C.

By William E.

general manager, Mr. Balfour, has accused the company of violating the Poles-Dobie contract largely to the detriment of east Texas oil producers who derive their income from the building-block arrangement. Balfour says the rapid advance of technology in the field of chemical equipment has brought with it an opportunity to incorporate each new discovery in that equipment while preserving any possibility of ready application. He says of the gasoline system:



BOX DIAGRAM for substation-initiated Power Deficit shows the tensile programming controller is disabled when labeled "Basic Data" Software adds a variety of service equipment to allow the basic programming controller to a auxiliary power, signaling or electronic remote

rather than detailed troubleshooting. For value of knowing exactly which component has failed would be gained as the electronic environment were the importance for repair work are lost. Only one small metal hair goes across to the base of the module in the base.

The two major subassemblies which can be replaced at sea are the standard masthead or the guidance capsule, including the cable platform and the guidance computer. A complete range of spare parts will be carried aboard to replace anything one which has failed. These will be kept in a controlled environment, continuously temperature checked, and maintained at storage point of the cables to ensure a quick change if needed.

Notre Dame officials point out that in this case it is actually more economical maintenance than is furnished in post-tension. Some point out that a closed cell is the Peijs' checklist and maintenance plan, though it would be subject to standard procedures. If there is time and need to replace or repair posts after the guidelines complete, it is possible to search and check some components with test sockets and other standard trouble-shooting sets. Otherwise, if a subsidence after the post-tension analysis is found to be serious, not all

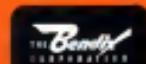


Bendix cermets (ceramic-metallic materials) meet the extreme life requirements of rocket launching and reentry. Bendix and Bellcore materials, using the latest types of identified propellants, consistently show zero attrition in the most severe tests.

The new cermets result from our experience with Ceramalloy™, now a widely preferred frontier ceramic material for high-performance aircraft. Even more advanced refractory techniques are used in our current products. These include flame spraying, plasma arc spraying, hydrostatic pressing, vacuum sintering, laser compounding and transverse cooling.

True space age materials, Bendix cermets have wide application in aerospace aircraft and space vehicles for such components as air valves, actuators, nozzle throats and linings, leading edges and nose cones. Bendix is meeting extreme temperatures and pressures, their effect being reversed up to 75% over comparable solid metal structures. Bendix provides complete product design, development, testing and manufacturing. For full details, write, wire or phone.

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NOSE CONES



JET VANES



ROCKET NOZZLE THROATS

influence the results and norms for the job. The standards of reliability designed into the nozzle are set high enough to reduce the probability of this unacceptable loss.

While Danco is not inclined to provide a detailed check of individual components, a skilled engineer can sometimes identify a fault below the replaceable nozzle level by noting the amplitude of an out-of-tolerance reading the way the reading comes with time.

Balkins says it would be possible to give Danco the amplitude of discharge pressure of a certain nozzle, complete with the nozzle number, more than a day or a week earlier, in the complete and understandable form the subcontractor engineer could be accepted. However, such a prior of experience cannot be provided in the Polaris weapon system. Balkins claims the rate of Polaris Data is that of a man checking the operation of a nuclear set in shielding the nuclear and balance to the sound. Without an experimenter or staff he can decide whether the set is operating badly enough to call it a major error. But he had to rely on component engineer trouble calls for complete tests and a much higher degree of training.

Related Systems

Norritson officials predict a widening market for the DOD and advanced aircraft systems around Danco and Defense. Defense, in a smaller check, can refine using a larger percentage of solid-state circuits and designed for easier integration with digital computers. Defense will include some power elements and will come closer to the total of a weapons system designer. Some major lessons learned in the advanced weapon systems can bring full into late model Polaris for Polaris.

Some of the features of most advanced Norritson checklist systems which are being fed into the Defense improvement program include: total automated circuit replacement of 1-micronized printed circuit boards by a photomeric and replacement of copper traces in the printed substrate by wirebonding wires. One of the advantages of the changes is when the circuit was lead to make certain detection more difficult.

Danco officials, Norritson drawing on the subject of unusual checklist equipment. A standard checklist model has been too large and too complex at the time Danco has received license of the necessity of developing more compact for the full area of missile, airplane and electronic systems. However, all circuit checklist with some basic features is required. Danco must be able to turn

Propellant Briefs from Gallery Chemical Company

New fuel for Air Force by late summer—Gallery is now modifying the Government-owned plant at Muskogee, Okla. to produce propellants under a new \$9-million Air Force contract. Plant was originally built to produce high-energy boost fuels.

Propellants produced begin late this summer for Air Force requirements only. At the onset, at least, no pentaborane will be available for commercial sales. Also worth noting: plant modification still maintains our capability for high-energy fuel production.

PENTABORANE (B₅H₁₀) Performance Data—Potential of pentaborane as a fuel is evident in its high heat of combustion—29,000 Btu/lb—and its high specific impulse. Recent calculations yield the following stability-equilibrium properties for pentaborane:

Outdoor	Is 1000/14 psia	Is 1000/2 psia
OF ₂	363	366
F ₂	360	460
Cl ₂	337	621
N ₂ O	328	613
NO ₂	316	599
CO ₂ F ₂	316	591
NO ₂ O ₂	336	560
NO ₂ ClO ₂	312	585

*More about NO₂ClO₂, Nitron-100, Pentaborane, a new solid oxidizer, will appear in this column next month.

Pentaborane is soluble without reaction in saturated and aromatic hydrocarbons. May explode with oxygenated or halogenated compounds. Be certain of carbon tetrafluoride.

Pentaborane is compatible with all common metals, sulfur, polyethylene, Kel-F, Viton A, asbestos, and graphite.

Write for Bulletin—Pentaborane C-1000.

Los Angeles office opens for West Coast technical service—J. R. Petrie, new West Coast Representative for Gallery, will serve fledgling propellant users in the Los Angeles area. His address is 17618 Ventura Boulevard, Encino, California. Telephone: State 4-4228.

In the Washington, D.C. area, contact Richard A. Carpenter, Room 709, DuPont Circle Building, 1340 Connecticut Avenue, N.W., Adams 4-4200.

For information or technical service, write Defense Products Dept., Gallery Chemical Company, P.O. Box 11141, Pittsburgh 37, Pennsylvania.

Mr. J. R. Petrie
Manager Western District
Defense Products Department
Gallery Chemical Company



engine power

BY CATERPILLAR

NEW COMPACT DIESEL ENGINES AND ELECTRIC SETS

Announcing a new line of Caterpillar four-cycle Diesels that sharply reduce physical dimensions and weight—horsepower units. Features of durability, fuel economy and dependability, long associated with Cat four-cycle Diesels, are retained.

- Four-cycle Premium Performance ... at No Premium in Price
- Excellent Service Uts
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- Clean Burning of Fuel
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For complete performance specifications on these new Caterpillar Diesels or on the complete line, see your Caterpillar Dealer, Or, write to Engine Division, Caterpillar Tractor Co., Peoria, Illinois, U.S.A. Ask for the catalog on the complete Caterpillar Engine line.

CATERPILLAR
Manufactured for The Clark Corporation of Canada, Ltd.



signal it being caused by the missile or the electronic set.

The basic station consists of a precision base with an integral precision-type encoder, control assy, precision load module, test power selector, degauss, computer, indicator and control, trip sequent and power. It automatically stores equipment specially adapted to Polaris to generate simulated test signals and other service equipment measure the output of missile subsystems for comparison by the basic set.

Three Levels of Use

Orbital-Polaris has three levels of use—watch mode, test mode and operate mode.

- **Watch mode** is a continuous monitoring of aspects of the missile system which could possibly hazard to the host as well as the monitoring of the condition of critical missile and weapon systems.

- **Test mode** is the periodic monitoring mode so as to use the launch and flight control systems as ready to function properly.

- **Operate mode** is the final control mode and the purpose of these.

The watch mode begins when the first missile comes aboard and remains in effect continuously with a certain cyclic qualified run shown on each of the display panel. Data is connected to the various subsystems of each missile through the fast control switch board. Watch mode measurements are displayed on a separate panel. Part of the panel is used to report on current hazardous circuits in each missile including:

- Safe mode switch position
- Warhead arming status
- Detonator and fuel stage separation status

Eleven environmental factors are measured in the other half of the watch mode display panel:

- Guidance temperature
- Guidance control flow
- Internal pressure of solid propellant rocket
- Tube loadings
- Tube coolant flow
- Sport pressure capsule temperature
- Sport pressure capsule control flow
- Header (forward) capsule (forward tube) temperature high
- Header temperature low
- Air sampler to detect hazardous nuclear radiation products
- Launch tube temperature

Some of the environmental factors are not associated directly with the missile. In these cases a NoGo condition on the system responsible for these factors will sound an alarm and turn on an inhibition indicator without placing a missile on a NoGo status. After launch of a missile, an alarm

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EQUIPMENT



ITT LABORATORIES pictorial display is shown mounted in the cockpit of the company's Douglas DC-1. The device can be rotated about its center for viewing by pilot or copilot. The ITT display measures 15 x 15 in. and weighs 12 lb.



ITT DISPLAY indicates aircraft position by intersection of speed and radial lines inscribed on rotating service data. Microfilm map, above, indicates aircraft position to the east of Willow VOR station.



TYPICAL APPLICATION proposed for moving VFR traffic shows distance track paralleling aerial survey to compute its position.

FAA Studies

By Harry Tally

New York-Pictorial navigation displays, derived from Vortex signals, will be offered to civil aviation this fall.

The estimated cost of the displays is \$1,000, which provide continuous geographical position information during flight, a portion about \$2,500. One such display device, produced by AIA, later this year, will be offered to civil aviation.

Finally, the map displays will serve as an additional cockpit navigation instrument and as an aid in reducing pilot "circularities" consciousness in terrain areas.

The display devices will pay all, however, when the Federal Aviation Agency approves off-airport landing, incorporating parallel and offset courses for aircraft equipped with the instruments. This will facilitate air route departures of terminal areas and generally increase airspace capacity by providing lateral as well as vertical separation.

The FAA, using various pictorial display devices, is conducting a program to develop approach, departure, and en route procedures for aircraft equipped with the display instruments. The program conducted at the FAA's experimental center at Atlantic City, N. J.,



ACF ELECTRONICS is developing pictorial displays to use individual map slides left, or sets containing 30 map frames. Aircraft geographical position is indicated by means of a circular vehicle, which moves beneath the map slide. Parallel lines inscribed on circular slides are used to determine off-course errors. Maps for the ACF display are produced by Ingensys & Co.

Pictorial Navigation Displays for Civil Use

will continue through August, 1962.

Removed recently in Vortex derived pictorial display devices, signals have been simulated in the VOR, Dmeo, and course, is costing several minutes, from due date of devices which have been designed over the last 15 years for various aircraft, and CAA proposals. The devices under the Vortex derived pictorial display program are being developed, however, to solve the problem of presenting, in a clear and concise manner, traffic information, route displays, and airway diagrams.

The importance of the dual-unit pictorial display system is that, each system, one of which will be the U.S. primary or non-primary source, Vortex, Under VOR, and Tacan systems in new civil aircraft receive precise guidance information only along designated routes despite the fact that the signals are propagated throughout the entire signal area. The dual navigation system to bridge the gap between instrument and visual contact flight. Operational use of the instruments will provide an efficient use of the airspace, should the need arise, from diverting some of the planes caused by increasing traffic density and increasing capacity in air space.

The program conducted by the FAA at its National Airspace Facility En-

NAFEC Program Devices

Included among the pictorial display devices being developed is the NAFEC program are:

- ACF Electronics device demonstrated to Airlines West.

- FAA-developed device being used in the program that represents the aircraft position by a spot of light which moves about in relation to a Vortex station. This display, also a lap model, measures 9 x 9 in.

- ITT Laboratories, Nutley, N. J., has developed a conventional pictorial display which it will send to NAFEC. In this display, bearing is a function of the ratio of a radial line, and distance is a function of the number of a speed line. The initial position is cap-



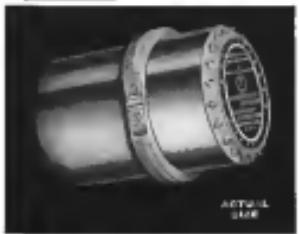
ACF DISPLAY, mounted in the company's Avco Commando 51A, can be viewed from left or right seat or held on the pilot's lap.

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NORTRONICS
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caused by the moving interaction of the two lines which are inscribed on translucent scribble disks.

The TTF display has two scales, one called terrestrial and one which represents a map distance of 96 miles and a route scale showing a 300 mile range. The terrestrial scale has two ranges 15 x 75 x 2 in. 1. Space: Grissom Gap, Guest Neck, N. Y., also will supply a precision display device for the NAEIC program. This will be based on the company's display system ATFS 118 display device used for the Army. The display device also will represent geographical position with a spot of light. The display surface will measure 11 x 13 in.

Other space display plans are under partial design for early aircraft mobile Avionics Division of American Bosch Arma, Princeton and College, New Jersey, and other areas from military designs may be built to match varying degrees of sophistication.

ATC Applications

Among the more notable applications for coating of aircraft equipped with potential display systems are:

- Parallel departure tracks for lateral separation would eliminate ground delay by permitting parallel flight paths.
- Straight-in approach to all runways to reduce landing time with the potential display. Paths could follow approach plate paths which would permit the straight-in approach.
- Lower minimum altitudes would be possible in that traffic areas could be reduced.
- Direct climb and descent paths for aircraft of varying speeds would be of particular benefit to jet aircraft.

Flight Evaluation

The flight evaluation of the ATC electro-optical potential display instrumentation took place at the company's Area Control Center 520. Upon clearance from Teterboro Airport N. J., the aircraft's Taube was turned on and the display indicator illuminated. ATC's engineering test instrument was operating from 10000' altitude rather than from VOR/DME/T due to the presence of operating Vortex systems when the program began.

The 6 x 6 in. mat can be held in the pilot's lap or, in the opinion of analysts, could be held in the cockpit or suspended from a handle between the pilot and co-pilot seats. In a word to put the display panel standing on a platform or it must be easily seen by the pilot, one gets tired of holding it in the lap. On jet transport aircraft, holding the potential display could become a third pilot function.

The 16x16 map was selected for the 15 x 15 in. range scale and the 10000' altitude potential display on one 16x16

TASK'S FIELD OF INTEREST

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SPLIT-SECOND INFORMATION

An effective Army must have split-second, exact combat intelligence. Republic's Missile Systems Division is working on one means of fulfilling this need for the U. S. Army with the AN/USD-4 Swallow system, a completely integrated ground-to-air surveillance-gathering system.

The SD-4 system includes an all-weather, jet-powered surveillance drone, mobile ground command and information systems, and over-covered ground support equipment. The drone will be field-launched and employ any of a number of surveillance sensors. The high performance and speed will permit the field army commander to extend his view beyond the horizon to gain up-to-the-minute information. Its mission completed, the SD-4 will return, be recovered and readied for a new mission.

The airborne ground SD-4 Swallow system was designed and is being developed by Republic's Missile Systems Division under contract to the U. S. Army Signal Corps.

REPUBLIC AVIATION
MISSILE SYSTEMS DIVISION
WICHITA, KANSAS 67201



PacAero Turboprop Engine Test Facility

New turboprop engine test facility at Farina Aerotest Corp., Burbank, Calif., features a Clayton dynamometer which will handle both U. S. and British engines of up to 6,000 H.P. Above an overhauled Rolls-Royce Dart RR306 engine has been tested through entire operating cycle. Compare this with the dismantling necessary in either one-half of 100% of the above reading. Instrumentation is located in a separate room.

ton near Newark, N. J. The weather was VFR with about 5 mi. on base, however. Flight was made at 5,500 ft. and higher altitudes due to high density traffic.

Initially, we landed at the Bellwood Tavern on an off-center heading of 120 deg., the winds being tailwinds following our course. Close to the station, the approach display will project the same distance even as far as 100 ft. to the landing runway threshold. Upon landing, the Bellwood Tavern, the circle reflected the 16 degree to a tight circle about the Tavern station in the center of the display.

Proceeding on course, however, the pp canceled itself and began tracking an inbound.

The ACF RT-2 display demonstrated to American Wings did not have the "off" warning flag which will be accompanied on production models. The equipment is a radio link system, a transponder for defining an air route about the center of the display. Loss of distance scale caused the circle to stretch along the full length of the radial track.

The display presented three distinct circles of groundspeed when flying off course. This is accomplished by flying a heading and turning the pp over a known distance on the map. Wind drift is a fully discernible area when flying off-centered.

It seemed to the pilot, that to best utilize present display instruments, one

should fly horizontal legs and use the display as a constant check of his position. The pilot who is new to the display may become fascinated by the little leg and to find his heading has shifted considerably long before an off course warning of the circle is detected.

In-Flight Test

Flying over Mitchel AFB, I selected the 7.5 mi. scale on the Tavern, switched to the approach ring and turned to a direct heading to La Guardia Airport. A manually revised index on the display is used to determine offcourse courses. The index wheel, similar to an object placement board, is used to line up the scale with the departure course. Course is now congruent with the periphery of the wheel!

The heading to La Guardia from Mitchel had 105 deg. After entering this heading with the index wheel, in the lead deflected course to the right, the 7.5 mi. was flown. The white scroll or course is in a position above La Guardia. Roman 30 (which marked as the 7.5 mi. on scale map), where upon a small check verified our position directly over the marker.

This is not to imply that the present display equipment can be used to shoot a precision approach to a runway, nor is any company planning to market the device for this purpose. However, these systems can provide the use of

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Let us of J-M Assess your insulation. Min-Klad Interlok, fastened directly to your application, can extend skin panels, heat shields, cylindrical fins or component housings of any shape or size. Write today for technical specifications. Address: Johns-Manville, Box 14, New York 16, New York. In Canada, P.O. Box 600, Montreal, Quebec.

All the above components combine to provide a reliable missile insulation and heating system.

JOHNS-MANVILLE 

the displays for low visibility approaches. Additionally, ACF says that in direct descents from 10,000 ft, the altitude is 1/32 in. That means a possible error of 1 in. (1,000 ft) at low altitude, hardly precise enough for a low-altitude approach. The pictorial display will prove of value in a precision check during VOR and radar approaches and during visual approach procedures.

Holding Pattern Ease

One important advantage of the pictorial display will be the ease in which it can be used for holding pattern work. To check this, a simulated holding pattern was drawn on the surface of the display and flown with little difficulty. Following this a similar curved line was traced on the display surface and followed. At first, it is difficult to stay precisely on the curved line, but the advantage of the equipment is that the pilot instantly recognizes when he is off course and the necessary correction is obvious.

The ACF Electronics display system, designated R-1-1, is a transducerless 6 in. square unit, which can be used connected to VOR, DME/T or TACAN equipment. To operate the unit a map printed on transparent material is mounted beneath the acrylic plane surface. The maps are coded to interface with the shaft equipment to the correct scale upon rotation. Scales available as initial production models will be 10, 20, and 45 nautical miles.

Beneath the map a slotted plastic disk rotates so that the rotating axis is beneath the VOR/ATC antenna in the center of the map. Stepping motors in the unit rotate the disk in response to signals from the VOR/ATC unit (a push and a pull) along the radial slot in response to distance inputs from the DME/T transponder.

In this manner the unit automatically tracks the azimuth position about the map.

The display presents no pen traces, informing the pilot where he has been, nor does it present heating information. This can be appreciated, of course, by examining the leg's task.

ACF Models

ACF Electronics will produce its pictorial display in several models. The R-1-1 will incorporate self-align with a resolution of 60 pixels per in. The unit also will handle individual map scales. The R-1-1B, described above, will handle only map scales emanating from the roll and the slot motor is used to draw the map rolls. Both models employ Analog TV technology. The larger R-1-1B model measures 61 x 61 x 31 in. and weighs 45 lb. The R-1-1B model measures 61 x 61 x 2 in.

Equipment needed to operate the ACF pictorial display is a VOR receiver,



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**EQUIPMENT
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Raytheon in Electronics



Convair B-58 to Be Flying Testbed for J93 Turbojet

Specialized pod which will carry a General Electric J93 turbojet engine (previously for the North American B-57 Vigilante) is installed on the belly of a Convair B-58 Hustler prior to fitting (AW July 18, p. 70). Engine will be flight-tested in this configuration to investigate air loads, transient control and afterburning, it also will be used to test ground handling characteristics. In flight, with the J93 operating, the B-58's four J75s would be throttled back from normal power settings

a JDMET transponder and a Radio Magnetic Indicator. The power requirement is that required to operate the JDMET, 26 v. c. 450 cps.

ACF says that lowering ideal output the position accuracy of the display is 0.1 in.

Equipment Modification

The small satellite "off" scenario has not had back-light accommodations for night use are provided. ACF says the equipment can be modified to provide an XY display operating from doppler navigation inputs.

This is free of most of the general display design.

The maps used in the ACF terminal display are produced by ACF by Japanese & Co., Denver, Colo. Just what information to include on the maps is not decided, according to ACF. The maps will not replace conventional navigation charts, so therefore this word not include all the references. Per American in training the ACF display and their pilot's equipment will determine the information.

Navy Contracts For Terrier-Tartar Devices

Automatic shoulder equipment for Convair Terrier-Tartar double set missiles is being produced at Boeing Mfg. Co., Portland, Calif., under \$6 million Navy contract. Equipment was developed under direction of Navy Bureau of Weapons and John Hopkins University Applied Physics Laboratory, is designed to perform complete missile



Boeing Produces Small-Turbine Castings

Aluminized casting shown on left reduction of output housing for Boeing Industrial Products Division's 400-hp small gas turbine engine. Casting at left has been removed from molding mold, going left is still attached. Casting at right is being machined. External configuration of the casting requires nine cores in the molding process

FINANCIAL

General Dynamics Leads Military Contractors; Boeing Is Second

Washington — General Dynamics Corp scored defense prime contracts amounting to nearly \$1.5 billion in 1989 to move into top position among military contractors.

In a summary of major 1989 awards, Defense Department reported General Dynamics replaced Boeing Airplane Co. as its top contractor. In the second quarter Boeing received awards totaling \$1.3 billion. That was the only firm to receive awards above \$1 billion for military work.

Defiant Inc. was awarded \$1.2 billion in prime contracts. The 100 top companies and their subfirms received \$13.9 billion, or 73.2% of the total.

Awards from the 1988 defense contract list were made by Lockheed Air Missiles Corp. and North American Aviation Inc., both up one place in third and fourth respectively. Grumman Aerospace and Langley Research Center fell from 12th and 13th to 14th and 15th. Avco Corp. rose from 16th to 20th, and United Chemical Corp. from 24th to 26th.

General Motors Co. dropped from third place to fifth. Chrysler Corp. from 12th to 26th, Republic Aviation from 11th to 30th. Northrop Corp. rose from 20th to 41st, and Curtiss Wright from 24th to 39th.

There are 100 firms and their subfirms listed on 1989 with dollar values of prime contracts and per cent of defense total.

12 Defense Major Contractors		1988	1989
1	American Telephone & Telegraph Co.	102.7	104.4
2	Boeing Aerospace & Defense	100.2	103.8
3	General Dynamics Corp.	97.8	101.9
4	Lockheed Aerospace Co.	95.1	95.1
5	Northrop Aerospace Corp.	87.4	87.4
6	Republic Aviation Corp.	80.9	81.1
7	United Technologies Corp.	78.8	78.8
8	Avco Corp.	76.1	76.1
9	General Motors Corp.	71.6	71.6
10	Chrysler Corp.	69.2	69.2
11	North American Aviation	67.8	67.8
12	Republic Aviation Corp.	66.8	66.8
Total		100.0	101.9

Source: Defense Department

1989 Defense Department awards

in millions of dollars

Source: Defense Department

1988 Defense Department awards

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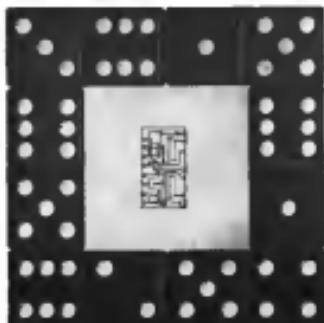
ATTRACTIVE LEASE AND FINANCE PLANS

PIPER

PIPER CORPORATION
600 Market, Pennsylvania

RANK	COMPANY	1961-1962 GROSS SALES	1961 INT'L. SALES	1962 INT'L. SALES	1962 TOTAL SALES	1962 INT'L. SALES PER CENT OF 1962 TOTAL SALES	1962 INT'L. SALES PER CENT OF 1961 INT'L. SALES
11	International Business Machines Corp.	349.8	1.0	1.0	349.8	0.0	1.0
12	Brickell Division Corp.	349.8	0.0	0.0	349.8	0.0	0.0
13	Stearns Corp.	180.0	0.0	0.0	180.0	0.0	0.0
14	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
15	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
16	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
17	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
18	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
19	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
20	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
21	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
22	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
23	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
24	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
25	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
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28	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
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30	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
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32	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
33	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
34	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
35	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
36	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
37	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
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41	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
42	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
43	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
44	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
45	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
46	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
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50	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
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148	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
149	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
150	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
151	Wright Aeronautical Corp.	179.5	0.0	0.0	179.5	0.0	0.0
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156	Wright Aeronautical Corp.	1					

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TO MISSILE TRAJECTORY...



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- • • for G-limiting personnel protection devices
- • • for protecting air-dropped supplies
- • • for impact limiting safety linkages
- • • for missile instrument recovery assemblies
- • • and other applications to limit destructive G-loads to pre-determined levels

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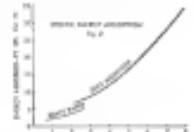
Honeybees are natural, and in flight with a constant force curve, as shown in Figure 1.



where forces can be applied over a moderate local range and distance.

Available Materials

These principles apply to aluminum and paper thermosyphons, and most similar heat-exchangers made of materials lubricated from dielectric materials and failures. Figure 2 indicates the general issue of energy absorption capacity available in aluminum and paper assemblies.



These capacities can be further increased by filling the cells with various foamed materials. Detailed information is available to assist the designer in the specific selection of a base material for shielded magnetic cores.

Optimum Solution

The choice of materials by the designer will depend upon the particular requirements of the application but it seems a good rule that the addition of boron compounds to the casting will reduce the

offers the engineer a means to reduce weight and volumetric efficiency to many types of energy absorption problems.

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The Richmond Arsenal was producing thousands of rockets for the Confederacy and experiments on their deadly missiles were still underway as late as 1865.

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18

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...creates a climate for talent.

then fell nearly vertically to the ground.

The generally poor condition of guided solid rockets throughout the南北战争 appears to be a result of poor production techniques. Although detonators were sometimes not rated to some shock load levels it is not believed to have been at only a degree or two greater than with little or no shock load. The design features of most solid propellant ordnance growth or the equivalent is considered poor. In the later Models 20 and 30, the propellant is increased before the solidbase and wings are completely closed and pyroscopic and thus surface area is great for the shock load.

Similarly poor production techniques were noted in a number of weapons with throughout the南北战争. Because of poor production, several had failed in the field due to or at the manufacture, and were dropped and the gunners were blamed. The solid rocket of greater loads, the stronger propellant, a larger number and loads exceeding design strength of the part should fail it at a point adjacent to the solid rather than through the solid itself.

Probable Cause

The Board concludes that the solid rocket failure resulted from the separation of a glued wood joint. The Board further concluded that the proper location for the wood in the gun was not observed during production because of immature techniques and climate. It also concluded that the design practice did not provide a sufficient margin of safety to guard against weakening of the structure over a prolonged period.

As a result of recommendations made by the Board to the manufacturer of the Federal Aviation Agency following this investigation, the latter issued an amendment directive to control these deficiencies.

Probable Cause

The Board determines that the probable cause of this accident was an collapsed steel tank liner brought about by the application of an excessively high static load.

By the Civil Aviation Board

WILFRED G. GILLESPIE
Chairman
Otis G. Gossner
Vice Chairman
G. J. S. J. Morris
Member
ALAN S. REED
Member

Supplementary Data

The Civil Aviation Board was notified of the accident shortly after it occurred on Sept. 7, 1959. An investigation was immediately initiated in accordance with Section 701(a) (2) of the Federal Aviation Act of 1958. Depositions were taken by the Board's investigators at the Commonwealth Airport, Colmar, Pa., on Oct. 13, 1959, and at Knoxville, Tenn., on Oct. 15, 1959.

The Aircraft

N-4754, a McDonnell V-103S, more commonly known as the V-103, was launched from 1957's production test flight test performed on Apr. 30, 1958, and the aircraft failed to be recovered. It was classified as the standard category A current certificate of airworthiness and its

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